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THE MORPHOLOGY AND DEVELOPMENT OF OBELIDIUM MUCRONATUM [1]

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(WITH 44 FIGURES)

During the more than sixty years which have elapsed since the publication of the researches of Leon Nowakowski on chytridiaceous fungi, many new types of these remarkable organisms have been discovered. The more recent finds, however, have yielded nothing so curious nor, evidently, so rare, as *Obelidium mucronatum* which was described and briefly illustrated by Nowakowski in 1876 (**1**). This species has remained practically unstudied since then, save for a very meagre description and figure by Sorokin in 1883 (**3**) based on a plant from Asiatic Russia, and the collection of two specimens by Henning Petersen in Denmark in 1910 (**2**).

Although I have examined during the past few years many hundreds of submerged insect exuviae, the habitat in which *Obelidium* was first found, I have never until now been able to find a fungus which resembled it in all details. To be sure, in a previous paper (**4**) I assigned tentatively to this species a problematical form found in caddisfly exuviae in Massachusetts, but I pointed out at that time that it differed in several important features from Nowakowski's fungus. As will be seen by comparison with the

[1] Paper from the Department of Botany of the University of Michigan, no. 631.

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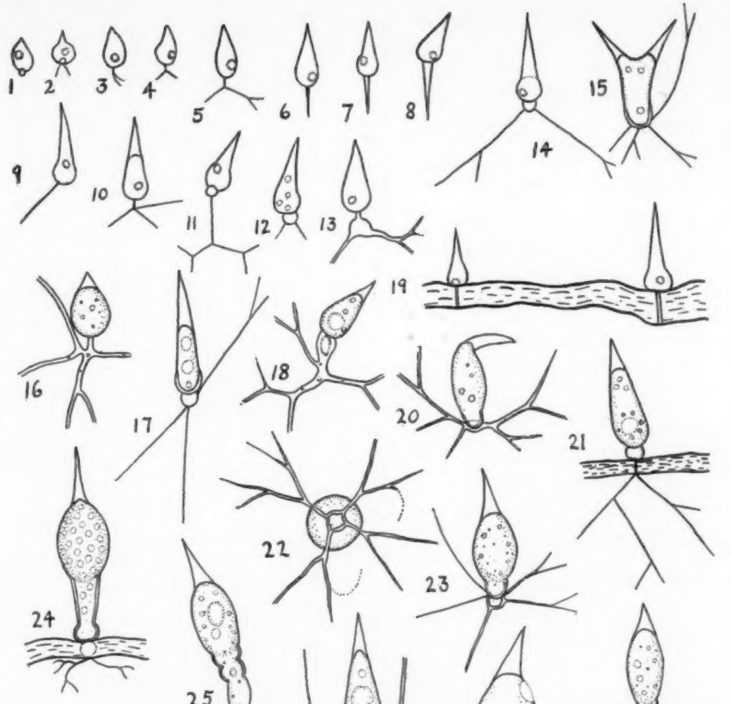
following account, it must be entirely excluded from *O. mucronatum,* a procedure I was unwilling to follow before studying more truly representative material.

Since none of the previous investigators of this species followed the complete development of the fungus it would seem of interest to describe this process which, it will be seen, possesses a number of interesting features. The specimens on which the following account is based were found in abundance in the exuviae of various species of midges and caddisflies collected in early June along the Huron River near Ann Arbor, Michigan. Fortunately, many stages in the development of the fungus were present and as a result a rather complete picture was obtained.

The zoöspore is spherical or slightly elliptical while in motion, is 2.5–3.5 μ in diameter, is provided with a small, highly refractive, centrally or eccentrically placed globule in its content, and possesses a single posterior cilium about 20 μ in length (FIG. 37). After a relatively short period of swarming (never more than an hour under the conditions of observation), the spore comes to rest and its cilium is retracted and forms a minute refractive globule on the periphery of the body (FIG. 1, 2). The subsequent fate of this globule could not be determined. That portion of the quiescent spore opposite the point of insertion of the cilium now elongates and, after about two hours, becomes broadly acuminate (FIG. 1). Eventually, this acumination will form the prominent apical spine which is a characteristic feature of the mature sporangium and it is of interest to note that, in contrast with certain other chytrids possessing a similar type of ornamentation (for example, *Chytridium Confervae*), it is generally the first structure laid down by the germinating spore. After, or sometimes coincident with its establishment, a very tenuous tube is produced on the opposite side of the spore body. This germ tube, which is the beginning of the rhizoidal system, when about 3–5 μ long usually branches (FIG. 2–5), although in many cases this may be delayed (FIG. 6–9). Sometimes the unequal expansion of the unbranched tube may result in the formation of a wedge-shaped structure (FIG. 6–8). Further development of the rhizoidal system in more typical cases involves the extension of the branches, the production of secondary branches, and in particular, the formation of a small apophysis



FIGS. 1–37.

just beneath the spore body. This apophysis originates in most cases from the inflation of the primary germ tube and concomitant portions of the branches (FIG. 12–14). Occasionally, however, it is formed from the germ tube alone (FIG. 11) and in rare cases fails to form at all (FIG. 16), producing the stalked plants which were noted by Nowakowski. Once established, the rhizoidal system becomes very extensive and profusely branched and radiates in all directions from the apophysis, particularly along the inner surface of the exuviae. Thus, the rudiments of the rhizoidal system are laid down before the apophysis is formed, even though in the mature thallus a reverse method of development may appear to have taken place. As may be seen from figures 9–12, during the establishment of the nutrient gathering system the spine has developed considerably and is often marked off at a very early stage from the rest of the body by a convex face (FIG. 10) which delimits its now highly refractive content. Save for the differentiation of the material in the spine, but little change has taken place in the contents of the " Centralblase " or body of the original, quiescent spore. The protoplasm remains homogeneous except for the persistent refractive globule. Eventually, however, the latter structure disintegrates, conspicuous vacuoles appear (FIG. 17, 18), and the protoplasm assumes a watery aspect. There is now noticeable a thickening of the basal portion of the wall of the sporangial fundament (FIG. 17, 20, 26). This modification may be confined to a short, cup-like region representing a part of the wall of the original spore body, or it may extend upward and form a stalk-like or funnel-like structure (FIG. 20, 26, 27). A gradual increase in the size of the whole thallus occurs but is less marked in the basal region of the sporangial fundament and the apophysis. Coincident with this, there is a strong expansion of that part of the sporangial fundament between the spine and the thick-walled base. This mid-region enlarges rapidly (FIG. 17, cf. fig. 23), becomes narrowly to broadly ovate, and at maturity contains the bulk of the protoplasm of the thallus which has passed into it from the rhizoids. A very inconspicuous septum is then laid down between the apophysis and the thick-walled base of what may now be termed the sporangium. This cross wall is rarely visible in mature sporangia but may often be seen in discharged, empty ones (FIG. 31).

After the protoplasm of the sporangial fundament has assumed the vacuolate and watery aspect mentioned earlier, there ensues a stage during which it becomes densely and uniformly granular (FIG. 29). Minute refractive droplets then make their appearance in the contents and, accompanied by a gradual "clearing" of the whole protoplasm, coalesce to form regularly-spaced, highly refractive globules (FIG. 39, 43, 44). It is during the densely granular stage just described that the rhizoids are finally drained of their contents and the septum laid down. During the last stages in the maturation, at which time the lines of cleavage of the individual spores may generally be observed (FIG. 32), the basal, mid-, and apical regions of the sporangium become very strongly differentiated from one another. The small apophysis, however, which was so conspicuous in the early stages of development becomes partially or completely hidden by the thick-walled sporangial base (FIG. 26, 27). It is of interest to note that the wall of this apophysis is evidently quite flexible and if the sporangium is tilted over by passing rotifers or protozoa it is quickly sprung back into its original position by the hinge-like action of the apophysis.

Variations in the general aspect of the sporangium are many, as may be seen from the figures. The most striking of these is the occasional production of two spines, resulting in a bifurcated structure (FIG. 15, 30). Often on single-spined examples the mucro may be strongly tilted (FIG. 20, 44), while another type which is generally found in plants living in large, recently evacuated exuviae where nourishment is probably readily available is shown in figure 41. Here the cylindrical portion of the sporangium is entirely omitted and the main body rests on the thick-walled, cup-like base. Indeed, in the present material only rarely did the stalk become so strongly differentiated from the lowermost part (FIG. 24, 27) as in Nowakowski's well known figure 1, plate 5 (loc. cit.). Still another variation in the Michigan material is shown in figure 25, where, in this instance, an apophysis has failed to form and the double-contoured sporangial base consists of two knob-like structures.

In addition to its typical *Rhizidium*-like method of development which has just been described, in which all parts of the thallus are

entirely within the integument, *Obelidium mucronatum* may sometimes exhibit a *Chytridium* habit of growth, *i.e.,* a part of the thallus becoming extramatrical. Thus, in figures 21 and 24 the sporogenous portion is separated from the rhizoids by the wall of the integument, the sporangium being intramatrical and the nutrient gathering system extending out into the water. The function of the rhizoids in these cases is not clear unless there is available organic material in the water. If not, it is possible that the intramatrical part may absorb food materials over its entire surface like a species of *Olpidium*. Another arrangement of the parts is shown in figure 19. Here the zoöspores have come to rest on the outside of the exuviae and each has produced a narrow tube which has bored through the wall of the integument. From the tip of this tube will be produced an intramatrical rhizoidal system (FIG. 28, 32, 38). The apophysis in these cases appears to be imbedded in the wall material of the exuviae and may be formed from the tube. Such versatility as this in method of development appears to be extremely rare if we are to judge from the literature, but more extensive observations on other chytrids will undoubtedly yield further instances.

There is great variability in the size of the mature thallus. The many dichotomously branching, non-septate rhizoids may be traced for distances of 25–100 μ on either side of the sporangium, which they appear completely to encircle (FIG. 42), and in their most tenuous, distal portions probably extend even farther. As they approach the sporangium they increase steadily in width, sometimes reaching a diameter of 5 μ where they join the apophysis. However, in small thalli (FIG. 33, 35) they may remain practically isodiametric throughout. The profuse development of the rhizoids in this species is indeed remarkable and exceeds that of any chytrid I have ever observed. Owing to limitations of space it has not been possible to show in any of the figures the full extent of the vegetative system.

The mature sporangia, which generally have their long axes at right angles to the plane of the rhizoids, may also vary considerably in size. Figures 33–35 and figures 39, 41, 43, 44, all drawn at the same magnification, illustrate some of the more common variations. Small sporangia are from 20–23 μ in height (includ-

ing the spine) by 7–8 μ in greatest diameter, whereas the large specimens may be 48–55 μ high by 17–20 μ in greatest diameter. The solid, refractive, apical spine varies in length according to the size of the sporangium, but is seldom more than one-third of the total length of the sporogenous body. As was noted by Nowakowski, the stalk-like part of the mature sporangium may be absent, but the cup- or funnel-like thick-walled base is always formed. On small sporangia this base is 4–5 μ in diameter by 4–5 μ in height; in larger examples it may be 8–12 μ in diameter by 5–10 μ in height. The stalk, when present, seldom exceeds 10 μ in length.

Discharge of the zoöspores was frequently observed. If exuviae containing mature sporangia are transferred to distilled water the zoöspores of the fungus are quickly liberated. In this process there is formed on the upper part of the sporangium a broad circular pore, the exact position of which varies from just beneath the spine to half way down the expanded body. This opening is evidently produced by the dissolution of the wall material since, in contrast to other rhizidiaceous chytrids, no discharge papilla seems to be formed. If such a structure is present it is too feebly developed to be seen in any view of the sporangium. Upon the initiation of discharge the contents of the sporangium pass through the pore *en masse* (FIG. 35), no traces of individual spores being seen except the globules. After 2–3 minutes' rest, during which time the zoöspores become separate entities (FIG. 36), they assume an individual jerking and hopping movement which increases in liveliness and soon transforms the group into a mass of rapidly whirling, posteriorly uniciliated bodies (FIG. 37). In spite of this intense activity, during which the spores often become separated into two or three masses, they all remain, for some reason, close to the discharge pore and their area of activity can be definitely circumscribed. However, no trace of a confining vesicle can be found and it is possible that they are restricted in the extent of their movement by their inability to free completely their cilia from the sporangium. After several minutes of vigorous concerted activity the spores disperse in all directions. Not all may leave the main group outside the sporangium at the termination of this first, preparatory swarming, in which case the re-

maining ones after a period of inactivity resume their efforts which this time are generally successful. Occasionally, a few spores fail to emerge at all from the sporangium and after brief periods of swimming and amoeboid crawling may finally come to rest and germinate *in situ* (FIG. 31).

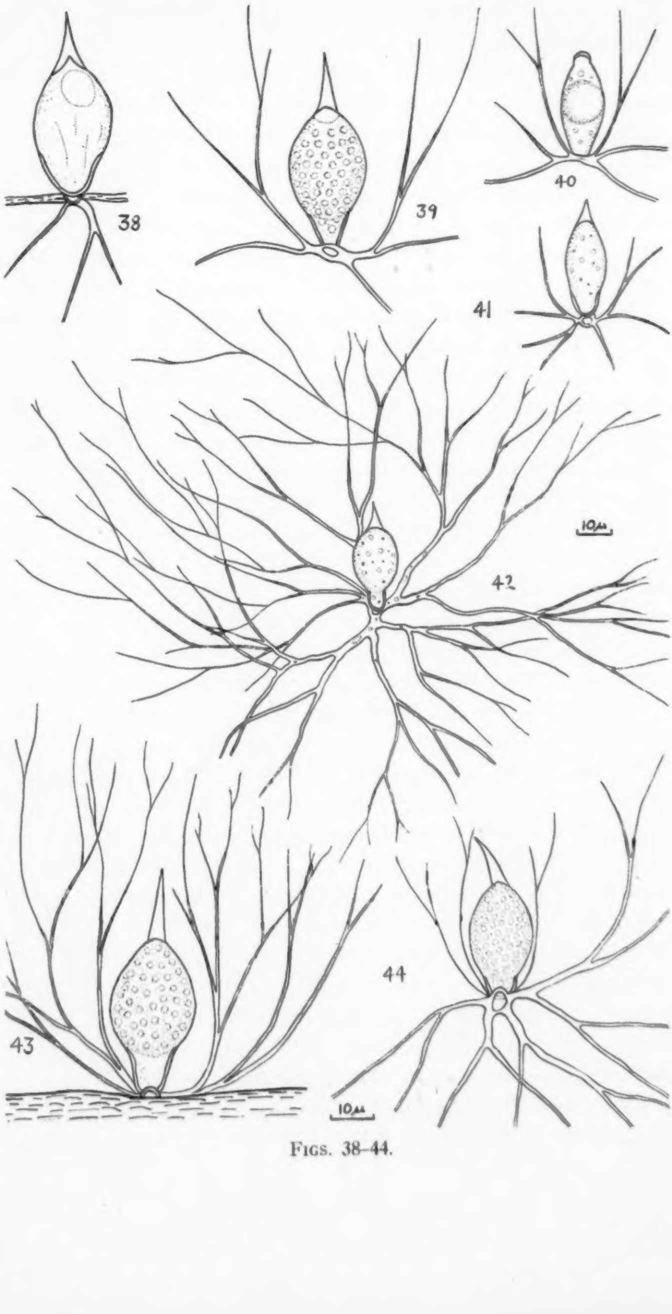
There were no significant variations in the method of spore discharge. Often, as the contents emerged through the pore the apical spine was tilted back until the passage was completed after which it usually resumed its former position. In empty sporangia, the spine, the thick-walled basal part, and the rhizoids remained very prominent in contrast to the somewhat shrunken and collapsed thin wall of the mid-region. On discharged sporangia with particularly rigid walls the circular shape of the discharge pore may be clearly seen (FIG. 27, 38).

No resting spores have been observed in this species. A single, spineless structure (FIG. 40) was found which contained a large globule similar to that found in the resting structures of most Phycomycetes, but there was no other evidence that this was actually the resting spore of the fungus. If, as is probable, such spores are found by subsequent investigators, I venture to predict that they will be formed as a result of a sexual process similar to, if not identical with that found in *Siphonaria* and *Rhizoclosmatium*.

DISCUSSION

A comparison of the Michigan material with that described by Nowakowski leaves little doubt as to the identity of the two. Both possess as constant features of the sporangium the solid apical spine, the more or less expanded mid-region within which is concentrated at maturity nearly all of the protoplasm, and the thick-walled, contiguous, basal region. In the present material differences in the shape of this basal part are numerous and in Nowakowski's account and figures a certain amount of variability in this respect is also noted. While Nowakowski did not observe the ciliation of the zoöspores he conjectured that these might be uniciliate, a fact which is confirmed in the present study.

The most striking departure in my material from the type species was the infrequency of the occurrence of a stalk in the basal



FIGS. 38–44.

part of the sporangium. Such a structure was considered typical in the German fungus. This difference is not considered significant however, and, as has been intimated, may be due to variability in the amount of available nutriment. The fact that a subsporangial apophysis was not observed by Nowakowski nor by Sorokin nor Petersen is probably to be explained by the fact that it is usually hidden by the base of the sporangium (FIG. 22) and unless early stages in the development of the thallus are followed, during which it is a relatively conspicuous object, its presence is not likely to be noted. Then too, in material mounted for observation the exuviae are usually much flattened and as a result the sporangia of the fungus are tilted so that the apophysis is further obscured (FIG. 33). Most of the figures were drawn from specimens in which the apophysis was visible.

When compared from the standpoint of size further resemblances between the European and American fungi are apparent. Nowakowski states that in typical plants the rhizoids form a circle about 160 μ in diameter around the sporangium. In the Michigan plants this varied from 50–22 μ. The sporangia of the type material were 32–56 μ high (mean 42 μ) by 8–15 μ in diameter, while mine measured 20–55 μ in height by 7–20 μ in diameter. The smaller sporangia in the latter material were generally found either in exuviae containing an abundance of other phycomycetous fungi or in old, somewhat desiccated ones, facts which seem to point to available food as a limiting factor in determining size.

Since its establishment in 1876, *Obelidium* has remained until very recently a monotypic genus. Lately, however (**4**), I described as *Obelidium hamatum* a form also found in exuviae which possessed a smooth, thick-walled, ovoid, stalked sporangium and a feebly developed rhizoidal system. The stalk, which in this species was thin-walled, bore two oppositely placed spines. In the same paper was provisionally described under *O. mucronatum* the fungus which has been previously mentioned here and which as a result of the present study must be excluded from Nowakowski's species. The sporangia of this doubtful species were broadly fusiform and rested on a cup-like, generally thick-walled base similar to that found in *O. mucronatum.* The rhizoids were delicate and radiated from a single point on the base. No pro-

nounced sporangial stalk was formed but this is not considered so significant as the fact that none of the sporangia possessed an apical spine. A study of the development of *O. mucronatum* reveals that the spine may be the earliest structure formed by the germinating spore and that it remains as a constant and characteristic part of the mature sporangium. Hence, the other fungus lacks an essential feature of *O. mucronatum* and must be considered distinct from it. Although it is apparent, then, that there exists at least another species of *Obelidium,* the sporangia of which do not possess a mucro, more should be learned about its development and particularly its method of zoöspore discharge before describing it as a new species.

Obelidium mucronatum in its method of development, general structural features, possession of a sub-sporangial apophysis, its type of zoöspore discharge and habitat is very similar to the other exuviae-inhabiting fungi, *Siphonaria, Rhizoclosmatium,* and *Asterophlyctis,* and there is little doubt that they are all closely related forms. It is also very probable that when the resting spores of *O. mucronatum* are found and their method of development followed, further similarities will be discovered.

In concluding it might be added that, while *O. mucronatum* is apparently a very rare organism, the three previous records of its occurrence (*i.e.,* from Germany, Asiatic Russia and Denmark), together with the present one from North America, would seem to indicate that it is a widely distributed species which will undoubtedly be found wherever the proper types of exuviae occur. Finally, this developmental study of the fungus has been of interest not only in determining the sequence of formation and origin of the parts of the thallus but also in providing further facts concerning the diversity of structure found among the chytrids.

SUMMARY

In the foregoing paper an account of the morphology and development of *Obelidium mucronatum,* a seemingly rare chytrid inhabiting the submerged exuviae of midges and caddisflies in the vicinity of Ann Arbor, Michigan, is given. The zoöspore after becoming quiescent and retracting its cilium produces an acumination which will form the apical spine of the mature sporangium.

Coincident with this or generally later, the rudiments of the rhizoidal system are produced from the opposite part of the spore body. Subsequently, an apophysis is formed by the inflation of the primary germ tube and portions of the primary branches. The sporangium develops from the expanded body of the original spore and at maturity consists of three parts, the solid apical spine, the narrowly to broadly ovate mid-region which contains the bulk of the protoplasm carried into it from the rhizoids, and a lowermost, cup-like, distinctly thick-walled region which may be prolonged into a funnel- or stalk-like structure. The mature sporangium is separated from the profusely branched and extensive rhizoidal system by a septum laid down between the base of the sporangium and the sub-sporangial apophysis. The posteriorly uniciliate zoöspores are delimited within the sporangium, emerge *en masse* through a sub-apical pore, and after their discharge rest for a time at the orifice before undergoing a period of preparatory swarming which terminates with their dispersal. Sometimes, instead of a *Rhizidium*-like method of development, *O. mucronatum* may exhibit a *Chytridium* habit of growth, a part of the thallus being extramatrical and the remainder intramatrical. No resting spores have been found. Similarity in body structure and method of development of *Obelidium, Rhizoclosmatium, Siphonaria,* and *Asterophlyctis,* all exuviae-inhabiting forms, suggests that they are closely related genera.

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EXPLANATION OF FIGURES

All figures were drawn from living material with the aid of a camera-lucida. All × 600 except figure 42 which is × 530.

FIG. 1, quiescent spore showing beginning of acumination and opposite it a refractive droplet, the remains of the cilium; 2, germinating spore showing branched rhizoids; the single germ tube is behind the body of the spore; remains of cilium still visible as a droplet; 3–5, stages in the development of the rhizoids, showing branching of primary germ tube; 6–8, germinating spores with wedge-shaped, unbranched germ tubes of considerable length; 9, young plant with elongated spine and long, unbranched germ tube; 10, young plant with the refractive, solid, apical spine already differentiated from the rest of the body; 11, young plant showing apophysis formed from germ tube alone; 12–14, more typical cases in which the apophysis is formed from the primary germ tube and portions of the branches; 15, 30, rare, two-spined thalli; 16, young stalked plant in which the apophysis has failed to form; 17, young thallus showing differentiation of thick-walled basal part of sporangial fundament; the apical spine and apophysis are also prominent in this specimen; the protoplasm has become vacuolate; 18, thallus in vacuolate stage but lacking, as yet, a well defined apophysis and thick-walled basal part to the sporangial fundament; 19, two spores germinating on the outside of the wall of the exuviae; a slender germ tube has been produced by each spore which has pierced the wall of the integument and will form within a rhizoidal system; 20, young thallus with strongly tilted apical spine; 21, thallus with sporangial fundament and apophysis formed within the exuviae, the rhizoids extending out into the water; 22, bottom view of a sporangium showing the rhizoids branching from the apophysis; the base of the sporangium was small and was hidden from view by the apophysis; 23, plant showing the beginning of the differentiation of the mid-region of the sporangium; 24, plant with strongly differentiated thick-walled basal stalk on the sporangium; the fungus is resting on the surface of the inner wall of the exuviae; the apophysis is apparently imbedded in the wall and the feebly developed rhizoids extend out into the water; 25, curious thallus with two knob-like thick-walled regions at the base of the sporangial fundament; 26, thallus showing beginning of thick-walled basal part; protoplasm thin and watery; 27, empty sporangium with rigid walls, showing stalk formation at base of sporangium and circular exit pore; 28, *Chytridium*-like thallus with sporangial fundament on outside of integument; the rhizoids intramatrical; 29, protoplasm of sporangium in coarsely granular stage; the rhizoids have been drained of their contents and a septum laid down; 31, discharged sporangium showing septum between apophysis and thick-walled base; three zoöspores have failed to emerge and one is germinating *in situ;* 32, mature, *Chytridium*-like sporangium showing faint lines of cleavage of zoöspores; 33, small discharged sporangium with single zoöspore which failed to emerge; 34, another small sporangium; compare figures 33, 34 with figures 39, 43, all drawn at the same magnification; 35–37, stages in the discharge of the zoöspores; 35, contents emerging *en masse* through a sub-apical pore; 36, spores assuming individuality; 37, spores undergoing preparatory swarm-

ing near sporangial orifice before dispersing; 38, large empty sporangium with rigid walls showing circular discharge pore; 39, mature sporangium with funnel-like thick-walled base; the globules of the spores are clearly differentiated; 40, aberrant plant without apical spine; possibly a resting structure; 41, type of plant found in exuviae rich in nutriment; 42, nearly complete thallus with sporangium tilted slightly out of position, $\times$ 530; 43, mature sporangium sessile on inner wall of exuviae, the rhizoids spreading along the bottom of the integument; 44, mature sporangium with tilted apical spine.

GARDENIA CANKER[1]

H. N. Hansen and J. T. Barrett

(with 1 figure)

In 1932 a disease affecting the stems and, less frequently, the leaves of several horticultural varieties of *Gardenia* (*G. jasminoides* Ellis) was observed to occur in greenhouses in the San Francisco Bay region of California. A short note describing briefly the disease and the causal fungus and also presenting proof of pathogenic relationship appeared in 1934 (**6**). Since then the disease has made its appearance in the following states: Illinois, Kansas, Massachusetts (**9**) ; Nebraska (**5**) ; Ohio (**8**) ; and Washington (**7**) and also in England (**1**). An early record of what may prove to be the same disease is found in Gardener's Chronicle for 1894 where Cooke (**2**) describes a gall disease of *Gardenia* and also mentions the association of a *Phoma* with it, though he considers this fungus to be secondary and in no way causal. In his book on " Fungoid pests of cultivated plants " (**3**) the *Gardenia* canker is illustrated and there can be little doubt but that it is the same disease dealt with here. The fact that Cooke called the associated fungus a *Phoma* shows that he, like recent British investigators (**1**), observed a single spore-type only, whereas we, as have other American workers, found two types to occur together in the same pycnidium.

Hansen and Scott (**6**) have presented adequate evidence of pathogenicity and other investigators (**1, 7, 8, 9**) have well described and illustrated the disease and its symptoms, and recommended specific prophylactic measures for its control. It therefore seems unnecessary to discuss further pathological phases and the present paper will deal mainly with the mycological characters of the pathogene which herein is described as a new species.

It was found that the pycnidia produced by the causal fungus

[1] Nontechnical assistance from employees under the Works Progress Administration is acknowledged.

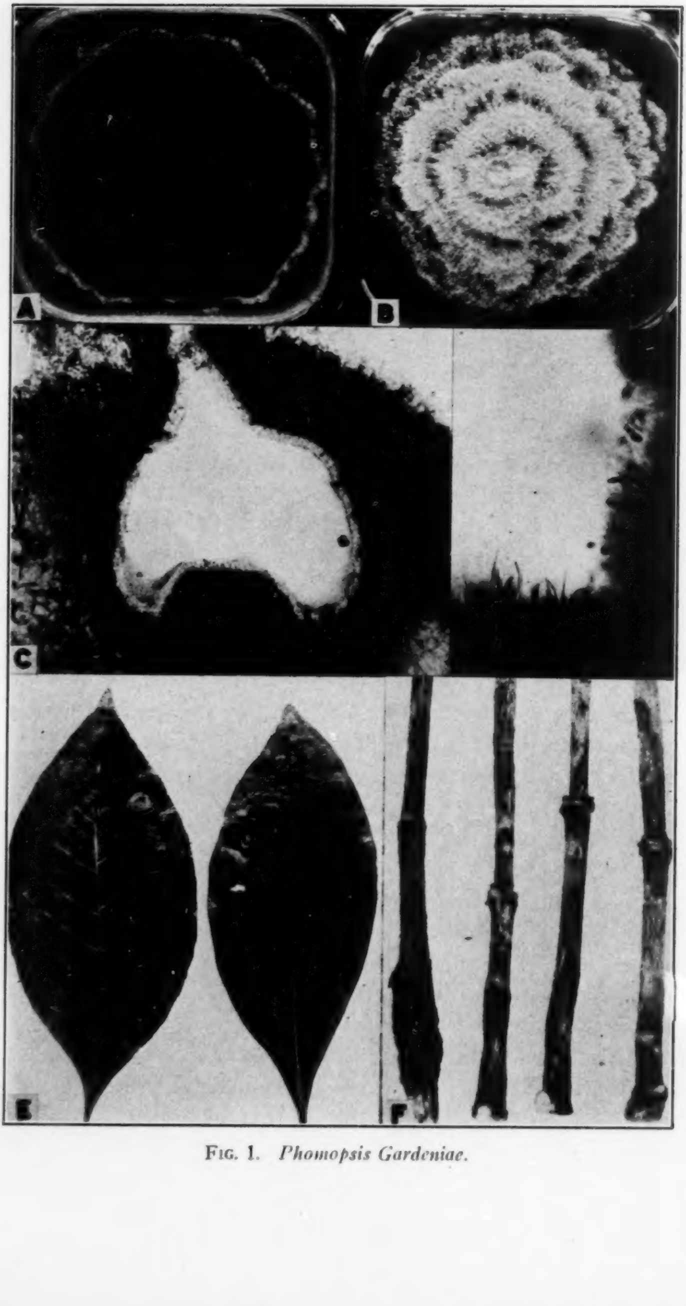

FIG. 1. *Phomopsis Gardeniae.*

were typical of the form-genus *Phomopsis* in the stromatic character of the pycnidial wall and in the unilocular condition of the spore-bearing cavity (**4**). The presence of two spore types A and B in the same cavity also is indicative of affinity with this genus. Cultures of the fungus were obtained from Illinois, Kansas and Washington and compared on various media with the California isolates. Strange to say all of the isolates from the four states were found to be not merely similar but apparently identical, a condition rarely found in isolates of any fungous species obtained from widely separated localities. This striking similarity together with the history of the occurrence of the pathogene would suggest that it had been distributed from a common center and as yet not been at any one place long enough to develop distinct ecological or geographical characteristics. On the other hand, a single host species and the nearly identical conditions of environment and cultural practices under which it is grown in greenhouses should be potent factors for stability and uniformity in the pathogene. Since no other species of *Phomopsis* has been reported to occur on members of the Rubiaceae it was rather difficult to intelligently select known species of the genus for comparative cultural studies. Four of a number of species at hand in our laboratory were therefore arbitrarily chosen for this purpose: *P. Sambuci* Ellis & Ev. (*Diaporthe*) from *Sambucus glauca* Nutt.,[1] *P. Mali* Roberts, from *Pyrus Malus* L., *P. cinerescens* (Sacc.) Trav. from *Ficus Carica* L. and *P. juniperovora* Hahn from *Juniperus virginiana* L. Our fungus differs materially in culture from all the above particularly in its irregular-zonate growth (FIG. 1, *B*) and in having dispersed pycnidia which are produced in abundance to within 5 mm. of the outer margin. The spores of the gardenia fungus are larger and the A type is characterized by having many oil globules, a condition apparently rare in *Phomopsis* where the typical number is two. Of the 107 species listed by Diedicke (**4**) only one (*P. Calophaceae* P. Henn) is described as having multiguttulate A spores.

In view of the pathological effect of this fungus on gardenia, its distinct cultural characters and morphological features we consider it a new species and propose the following name:

[1] *Sambucus glauca* is a member of the family Caprifoliaceae which is adjacent to the Rubiaceae.

Phomopsis Gardeniae sp. nov.

Pycnidia scattered, solitary, arising beneath the epidermis and becoming erumpent; black, carbonaceous, ostiolate, subglobose, 350–650 × 300–500 μ (FIG. 1, *C*). Cavities of pycnidia on leaves or in culture are unilocular, usually with a stromatic protuberance from the basal wall (FIG. 1, *C*). Cavities of pycnidia produced on the stem are frequently very irregular and they sometimes give the impression of being multilocular. Conidiophores continuous, hyaline, awl-shaped, 12–18 × 2.5–3.3 μ. On these conidiophores two types of conidia are borne. *A*, continuous, hyaline, elliptic-fusiform, many-guttulate, 6.8–12.3 × 2.7–4.3 μ, mostly 8.5–10.2 × 3.2 × 3.6 μ (200 spores). *B*, continuous, hyaline, filiform, curved or flexuous, 13.6–32.5 × 1.1–2.1 μ, mostly 18.2–27.2 × 1.4–1.8 μ (200 spores).

Pycnidiis dispersis, subepidermicis, erumpentibus, ostiolatis, nigris, carbonaceis, subglobosis, 300–600 × 250–500 μ. Sporophoris continuis, hyalinis, subulatis, 12–18 μ longis, 2.5–3 μ latis. Sporulis biformibus aliis continuis, hyalinis, ellipsoideo-fusoideis, pluriguttulatis, 6.8–12.3 × 2.7–4.3 μ, plerumque 8.5–10.2 × 3.2–3.6 μ; aliis continuis, hyalinis, filiformibus, curvulis, incinatus, 13.6–32.5 × 1.1–2.1 μ, plerumque 18.2 × 27.2 × 1.4–1.8 μ. Hab.: in ramis et foliis *Gardeniae jasminoides* Ellis (Rubiaceae) in U. S. A. et Europe.—A culture of the fungus has been deposited at the Centraalbureau voor Schimmelcultures at Baarn, Holland.

SUMMARY

A hitherto undescribed species of *Phomopsis* causing a definite canker and gall disease on Gardenias (*Gardenia jasminoides* Ellis) is herein described as *Phomopsis Gardeniae*. This pathogene is apparently confined to a single host species but with a rather wide geographical distribution.

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EXPLANATION OF FIGURE

FIG. 1, *A*, culture of *P. Gardeniae* viewed through the bottom of the plate. × ¾; *B*, culture of *P. Gardeniae*. Note the peculiar marginal growth. × ¾; *C*, section through a pycnidium (note the ostiole and also the stromatic cushion in the base). × 105; *D*, sector from pycnidium showing both *A* and *B* spores present. × 425; *E*, leaves of *Gardenia* showing typical zonate spots caused by the pathogene. × ¾; *F*, stems of young plants artificially inoculated. The one on the extreme left 8 months after inoculation, the others 3 months after.

NEW AND UNUSUAL AGARICS FROM NORTH AMERICA—I [1]

Alexander H. Smith

(with 4 figures)

In recent years the microscopic characters of the species in the Agaricaceae have been given an increasingly important role in recognizing species and establishing relationships. Since this information is not now available on many of the so-called "American species," and because of repeated requests from abroad for it, I shall endeavor to describe these characters as rapidly as the information can be accumulated.

In this paper the results of microscopic studies on the types of certain species of *Collybia* and *Omphalia* are presented along with information on certain of my own collections. In all, thirty-six species are considered, two of which are described as new. One new combination is proposed. The species have been selected either because of their outstanding microscopic characters or because of some confusion which previously existed.

The type specimens of Murrill's species are deposited at The New York Botanical Garden, New York City, and those of Peck's species are at the New York State Museum, Albany, New York. The writer wishes to express his appreciation to Dr. F. J. Seaver of The New York Botanical Garden for the opportunity to study Murrill's material, and to Dr. H. D. House of the New York State Museum at Albany for the opportunity to study Peck's specimens.

The iodine solution used in studying the spores is the same as that used for species of *Mycena,* Smith (**14**). All the collection numbers and photographs are the writer's unless otherwise stated. The collections cited have been deposited in the Herbarium of the University of Michigan. The color names in quotation marks are taken from Ridgway, Color Standards and Nomenclature, 1912.

[1] Papers from the Herbarium of the University of Michigan.

COLLYBIA ALBIPILATA Peck (FIG. 1, *f, h, i, j, k*).

Pileus 1–2 cm. broad, convex, becoming plane, densely pruinose at first from projecting cystidia, " clove brown " to " olive brown," fading slowly to " buffy brown " or pale grayish, not striate; flesh thin, tough, pliant, odor and taste not distinctive; lamellae close, broad, sinuate or rounded and adnate, white to grayish, pruinose from cystidia; stipe 2–4 cm. × 1.5–2 mm., with a long pseudorhiza covered by an ochraceous tawny mycelium, concolorous with the pileus above or pallid, densely pruinose pubescent from projecting cystidia, pliant and tough; spores 5–6 × 3–3.5 μ, smooth, ellipsoid to drop-shaped, yellowish in iodine; basidia four-spored; pleurocystidia and cheilocystidia abundant and similar, (40) 50–70 × 8–12 μ, with a long cylindric neck above a slightly inflated basal portion, shorter individuals more or less fusoid ventricose; pileus trama corticated by a layer of clavate pedicellate cells (10–15 × 8–12 μ) with abundant long hyaline cystidia projecting.

Lake Crescent, Wash., Oct. 6, 1935 (*3028*). Attached to buried cones. This species is known both in eastern and western United States. The drawings were made from the type specimens. In iodine the body of the gill and pileus trama turned pale-yellow but the palisade layer became brown. The cystidia on the stipe are hyaline and usually with a broader base than those on the pileus. The corticated pileus, small spores, cystidia on cap, stipe and gills along with the habit on buried cones and the mycelioid pseudorhiza distinguish this species. The microscopic characters of the type are similar to those given above for the western collection.

COLLYBIA ALBOGRISEA Peck.

The type specimens are well preserved. The fruit-bodies were cespitose and apparently of a rather firm consistency. A reddish brown tinge is present in the dried specimens and in general the aspect is that of *Collybia acervata* (Fries) Quél. The gills are broad and distant however. The pileus is corticated by a palisade of small upright pedicellate cells 10–12 (15) × 6–10 μ. The body of both the cap and the gill trama becomes vinaceous red in iodine. The spores measure 6–8 × 3.5–4 μ, are smooth, ellipsoid, and become yellowish in iodine. The basidia are four-spored and no differentiated cystidia are present on either the sides or edges of the gills. This species is closely related to *Collybia strictipes* Peck in the reaction of the flesh to iodine and in the structure of the pileus cuticle.

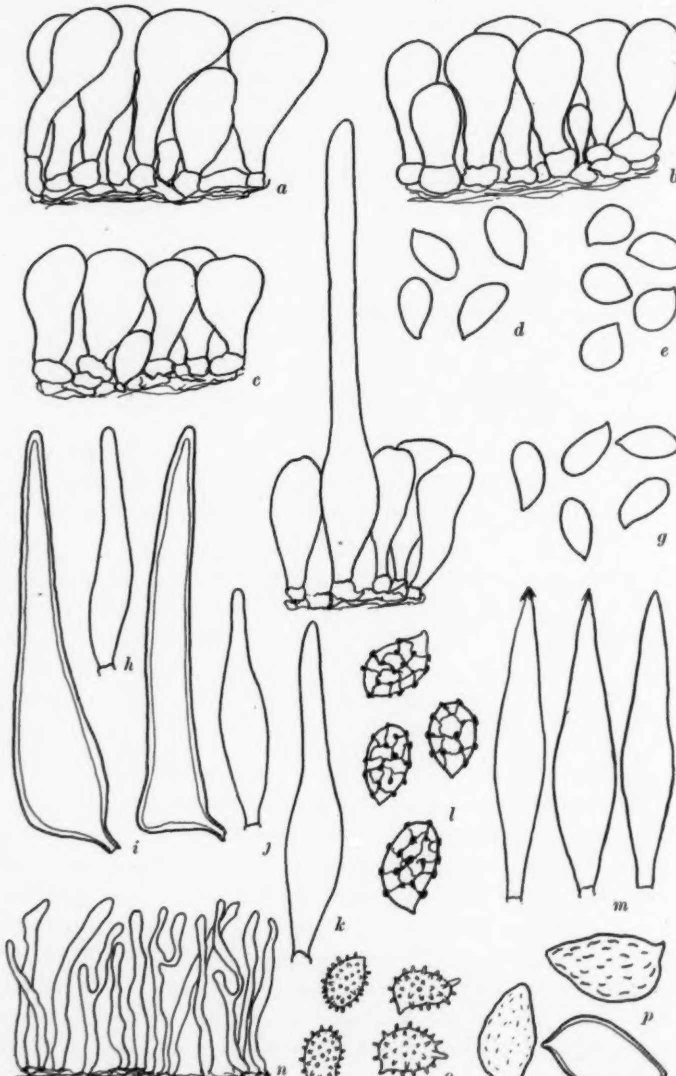

FIG. 1.

COLLYBIA BADIÏALBA Murrill.

The type consists of two well preserved specimens. The dried caps are dark reddish brown. The spores are globose, 3.5–4 μ, and turn greenish yellow in iodine. Cystidia are not differentiated on either the sides or the edges of the gills. The basidia are four-spored. The pileus and gill trama are homogeneous and not otherwise distinctive. This is a lignicolous species somewhat similar to *Collybia oregonensis* Smith but easily distinguished by its globose spores.

COLLYBIA CINCHONENSIS Murrill (FIG. 1, *l, m*).

The type consists of two well preserved fruit-bodies which are now pale leather brown and remind one somewhat of dried specimens of *Collybia dryophila.* When revived the flesh is soft and fragile. The pileus trama does not revive well but appears homogeneous and not otherwise distinctive. Cystidia are present but rare on both the sides and edges of the lamellae. They measure 46–63 $\times$ 8–14 μ, are fusiform with sharply pointed apices, and frequently have a slight incrustation over the apex. They remind one strongly of the cystidia of *Tricholoma melaleucum* (Fries) Quél. The basidia are four-spored. The spores measure 7–9 $\times$ 4–5 μ, are ellipsoid in outline but taper to a point at one end and are minutely roughened. The projections turn dark violet black in iodine, and a netted pattern is visible under an oil immersion lens. The spores and cystidia should aid materially in recognizing this species. The pileus and gill trama are yellowish in iodine.

COLLYBIA DENTATA Murrill.

The type specimens resemble those of *Collybia ligniaria* Peck very closely in color and stature when dry. The pileus trama is similar to that of *Mycena galericulata* (Fries ex Scop.) Quél. A thin pellicle covers the surface and beneath it is a region of inflated cells of rather indefinite limits. The remainder is the floccose filamentose type usually found in the larger species of *Mycena.* Pleurocystidia are not differentiated. Cheilocystidia are imbedded in the gill edge, measure 26–36 $\times$ 8–12 μ, are clavate, and their apices are set with minute rod-like projections.

The basidia are four-spored. The spores are broadly ellipsoid, bluish in iodine, and measure 8–10 × 5–6 μ. This species should be excluded from *Collybia* and placed in *Mycena*. A new combination is not proposed because it is very likely that, when the larger species of *Mycena* have been revised, it will be possible to refer it to a previously described species.

COLLYBIA DOMESTICA Murrill (FIG. 1, *n, o*).

This is a short stiped broad caped species, dried specimens of which in a superficial way resemble dried material of *Collybia myriadophylla* (Peck) Sacc., but are more fragile when revived. The pileus trama is homogeneous below a surface layer of narrow somewhat branched more or less upright hyaline hyphae which cause the cap to appear subtomentose. Cystidia are poorly differentiated and only occasionally project slightly from the hymenium. They resemble sterile basidia except for a more tapered apex. The basidia are four-spored. The spores measure 5–6 × 3–4 μ, turn yellowish in iodine and are minutely echinulate. The pileus and gill trama are yellowish in iodine. The stipe is solid and covered by a coating of fine hyphae similar to that found on the pileus. The notes with the type at The New York Botanical Garden describe the spores as echinulate and the present study has confirmed this point.

COLLYBIA EARLEAE Murrill.

The type consists of an ample collection of well preserved fruit-bodies. It is a very firm cartilaginous reddish-brown fungus. The pileus and gill trama are homogeneous and the basidia are four-spored. The spores measure 7–9 × 5–6 μ, turn yellowish in iodine and are broadly ellipsoid. Pleurocystidia are not differentiated. The cheilocystidia measure 23–25 × 6–9 μ, are clavate and have very finely echinulate apices. In consistency it approaches the fleshy species of *Marasmius*.

COLLYBIA FIMITARIA Murrill.

The type consists of several fruit-bodies. The pilei have dried cinnamon-brown, and coarse striae extend to the disks. The aspect is that of a medium sized *Psathyra*. The spores, however, are hyaline in KOH, turn yellowish in iodine, and measure 7–9 ×

4–5 μ. The basidia are two-spored. No cystidia are present either on the sides or edges of the gills. The pileus trama could not be revived well enough to show the nature of the cuticle.

COLLYBIA FULVIPES Murrill.

The type specimen reminds me of *Marasmius elongatipes* Peck but the base of the stipe is covered with bright yellowish brown fibrils. The consistency is not that of a *Marasmius.* The pilei are dark reddish-brown. Pleurocystidia and cheilocystidia are similar, narrowly fusiform with acute apices, hyaline, and measure 26–32 × 5–9 μ. The pileus and gill trama are characterized by dark reddish brown walls. The upper portion of the pileus trama is formed by a broad region of compact hyphae which gives the appearance of a parenchymatous layer in tangential section.

COLLYBIA FULVODISCUS Murrill.

This is a slender species. The pilei of the type are near cinnamon-buff on the margin and reddish-brown on the disk. The gills have a cinnamon tinge, and the stipes are reddish-brown. The upper region of the pileus trama appears pseudoparenchymatous in tangential section. Pleurocystidia and cheilocystidia are similar and very abundant. They measure 40–60 × 9–14 μ, are smooth and hyaline, the midportions are slightly enlarged and the apices obtuse. The spores measure 5–6 × 2.5–3 μ, and become faintly greenish-blue in iodine.

COLLYBIA GLATFELTERI Murrill (FIG. 1, *a, c; 2, a*).

The type consists of two large fruit-bodies which are pale ochraceous-buff in color and very fragile. The one tagged as the type is quite striate on the margin of the pileus. The pileus trama is corticated by a palisade of clavate hyaline cells 20–30 × 8–12 μ. Cystidia are abundant on the sides and edges of the gills. They measure 60–80 × 9–15 μ, are hyaline and broadly fusoid with pointed apices, and originate deep in the gill trama. The spores measure 5–6 × 3.5–4 μ, are smooth, ovoid to subellipsoid and turn yellowish in iodine. The trama of the gills and pileus turns vinaceous-red in iodine, and opaque contorted hyphae resembling lactifers in appearance are scattered through the tissue of the stipe and pileus. For additional comments see *Collybia tenuifolia.*

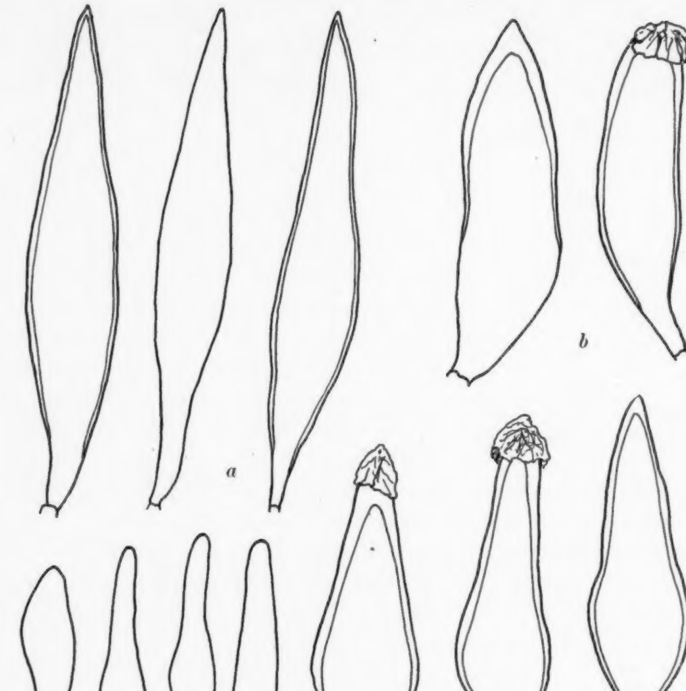

FIG. 2.

COLLYBIA GRISEIFOLIA Murrill.

The pileus of the type is dark blackish-brown, the gills drab, and the consistency distinctly fragile. The spores measure 8–10 $\times$ 5–6 μ, are smooth, hyaline and turn yellowish in iodine. The basidia are four-spored. Pleurocystidia are not differentiated. The cheilocystidia are imbedded in the gill edge, measure 24–28 $\times$ 6–9 μ, are clavate and the apices are covered by fine rod-like projections. The pileus trama is compact and pseudoparenchymatous near the surface. The cystidia relate this species to the larger Mycenas, but the action of iodine on the spores and the compact pileus trama do not allow it to be placed there.

COLLYBIA LUDOVICIANA Murrill (FIG. 1, *c, g*).

The type consists of a group of well preserved fruit-bodies. The pilei of the dried specimens are whitish, the gills ochraceous tawny, and the stipes tawny and polished. When revived the specimens ar not at all *Marasmius*-like. The pileus is corticated by a palisade of clavate or pear-shaped hyaline cells. Cheilocystidia are present and measure 28–30 $\times$ 7–11 μ. They are clavate to saccate in outline. The majority were smooth, but in a few small distinct projections were scattered over the apices. The spores measure 4–5 $\times$ 3 μ, are smooth, ellipsoid and yellowish in iodine. Basidia with distinct sterigmata were not found. The pileus and gill trama become vinaceous-red in iodine and contorted hyphae resembling lactifers are present in the tissues of the pileus and stipe.

COLLYBIA MARASMIIFORMIS Murrill (FIG. 2, *e*; 3, *e, h, i*).

The type consists of rather poor material but it is evident that the species is very cartilaginous. The pilei when dry are pale grayish-buff and the stipes are faintly pubescent. It revives well, is rather tough in consistency, and may possibly be a better *Marasmius* than *Collybia*. However observations on more material should be made before making such a change. The spores are globose, 2.5–3 μ, smooth and yellowish in iodine. The basidia are small (18–22 $\times$ 5–6 μ) and the sterigmata very fine and inconspicuous. The pleurocystidia are very numerous and measure 21–37 $\times$ 8–12 μ, are filled with a refractive yellow sub-

stance, and are similar in shape to cystidia of *Hypholoma dispersum* (Fries) Quél. The cheilocystidia are similar in color but many are blunt and furnished with hyaline proliferations which cause the gill edge to be obscured in a tangled mass of hyphae. The pileus trama is homogeneous but large cells filled with a bright yellow content are scattered through it. The stipe is solid and its tissue is also characterized by the presence of numerous enlarged hyphae with bright yellow contents. These are exceptionally numerous near the periphery where many project as cystidia. As in the cheilocystidia, these also are frequently furnished with one or more hyaline proliferations which cause the stipe to appear densely pruinose or minutely pubescent.

COLLYBIA NIGRITIFORMIS Murrill.

This is a thin membranous species with a somewhat haematite colored pileus, a darker concolorous stipe, and ochraceous tinged gills in the dried condition. The pileus trama is homogeneous. Pleurocystidia are imbedded in the hymenium, measure 27–38 × 8–11 μ, and are fusoid with sharp acuminate apices. The cheilocystidia are more filamentose and contorted, measure 30–38 × 8–11 μ and have obtuse apices. The basidia are four-spored; the spores measure 5.5–7 × 3 μ, are hyaline, narrowly "drop-shaped" and turn yellowish in iodine.

COLLYBIA SETULOSA Murrill (FIG. 3, *a, b, c, g*).

The type consists of a single well preserved fruit-body. The pileus has dried a rather dark purplish-brown color and the gills pale ochraceous. The stipe is cinnamon-brown and covered by a brown pubescence. The pileus is corticated by a palisade of cystidia with dark brown contents and thick-walled brown setae intermingled. The cystidia of this layer measure 28–36 × 8–12 μ and are more or less fusoid-ventricose or with acute apices. The setae measure 50–180 × 7–12 μ and taper gradually to a point. The spores measure 8–10 × 7–9 μ, are globose to subglobose, smooth, with a rather oblique apiculus, and turn yellowish in iodine. The basidia are four-spored. Cystidia are abundant on the sides and edges of the gills, but are very different from those of the pileus. They measure 60–80 × 12–20 μ, are smooth, hy-

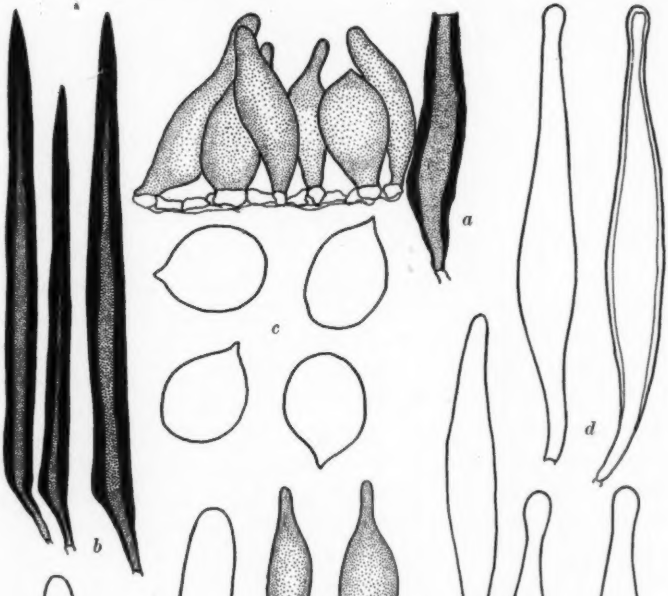

FIG. 3.

aline, have blunt apices and the midportion somewhat inflated. The cortex of the stipe is composed of an outer region of cells with dark reddish-brown walls and the surface is densely clothed with long thick-walled reddish-brown setae similar to those on the pileus or longer and somewhat flexuose. The fruit-bodies revived well and somewhat resembled dried specimens of *Collybia tenuipes.*

COLLYBIA SINUATA Murrill.

The type consists of one large fruit-body which resembles *Tricholoma innamoenum* (Fries) Quél. in stature. The cap dried alutaceous with a tinge of vinaceous, the gills almost " buckthorn brown " and the stipe pallid. The pileus trama is homogeneous, cystidia are not differentiated on either the sides or edges of the gills and the basidia are four spored. The basidia turn dark reddish brown in iodine. The spores measure 10–12 × 6–7.5 μ, are ellipsoid to ovoid, hyaline, and turn dark reddish-brown in iodine. For further comments see *Tricholoma platyphyllum* Murrill.

COLLYBIA STRICTIPES Peck (FIG. 1, *b, d*).

This is considered by some to be a synonym of *Collybia nummularia* (Fries) Gillet. The spores of the type measure 7–8 × 4 μ, are smooth and narrowly ovoid. Cystidia are not differentiated except on the gill edge where they are contorted and filamentose. The basidia are four-spored. The pileus trama is corticated by a palisade of pyriform or clavate hyaline cells. The pileus and gill trama become vinaceous-red in iodine.

COLLYBIA SUBLATERICIA Murrill.

Pileus 1–3.5 cm. broad, convex, glabrous, moist and opaque, hygrophanous, when moist " chestnut brown " to " burnt umber " or in age dull " testaceus," fading to " pinkish cinnamon," in age the cuticle sometimes cracks radially and the pileus appears subrimose; flesh thin but firm and rather brittle, watery testaceous when moist, " pinkish buff " when faded, odor sharp and strong (or lacking in old fruit-bodies), taste strongly farinaceous; lamellae close to crowded, moderately broad, bluntly adnate or slightly toothed, " pale pinkish buff," edge even, in older specimens sometimes staining reddish-brown; stipe (2) 3–6 cm. × 2–5 mm., equal,

cartilaginous, fragile, tubular, glabrous or with minute fibrillose flecs at the apex, concolorous with the pileus or paler; spores 6–8 × 3.5–4 μ, ellipsoid, smooth, hyaline or yellowish in iodine; basidia four-spored; cystidia not differentiated; pileus trama homogeneous.

The above description was drawn from specimens collected in the vicinity of Lake Crescent, Washington, during the fall of 1935 (*2584; 2790; 3292*). Murrill (**12**) described the spores as 6–7 μ long and subglobose. The spores of the type measure 6.5–8 × 3–3.5 μ and turn yellowish in iodine. No differentiated cystidia were found on the type, its basidia are four-spored and the pileus trama is homogeneous. The dry specimens have dark reddish-brown stipes, pale cinnamon gills and somewhat reddish-cinnamon pilei with more or less vinaceous disks. The species apparently resembles *Collybia nitelina* (Fries) Quél. somewhat, but the latter is described as having roughened spores. The only specimen which I have seen at all resembling *C. nitelina* was characterized by "Mars orange" to "orange rufous" colors when moist. When faded it was "pale orange buff." The spores measured 5–6 × 4–5 μ and had slightly roughened walls.

COLLYBIA TENUIFOLIA Murrill.

The type consists of a large well preserved specimen which has somewhat the stature of *Collybia platyphylla* (Fries) Quél. It is very fragile in the dried state. The disk has dried dark reddish-brown and the marginal area ochraceous-buff. The stipe is white. The pileus trama is corticated by a palisade of pyriform or clavate hyaline cells. The gill and pileus trama becomes vinaceous-red in iodine. Cystidia are abundant on the sides and edges of the gills, measure 40–60 × 10–17 μ, are smooth, hyaline, and possess an abruptly tapered narrow neck above an inflated midportion. The spores measure 5–6 × 3.5–4 μ, are smooth, broadly ellipsoid, and yellowish in iodine. The basidia are four-spored. The microscopic characters of *C. Glatfelteri* and *C. tenuifolia* are practically identical, and, judging from the descriptions of the two, they are very similar macroscopically. It is very likely that *C. Glatfelteri* is a synonym of *C. tenuifolia* and a study of fresh specimens should be made with this in mind. I have never seen either one in the fresh condition.

COLLYBIA TRULLISATA Murrill (FIG. 3, *d, f*).

The type consists of several good specimens. The pilei are fragile and " pale cinnamon buff " in color and the stipes have long pseudorhizas. The pileus trama is homogeneous but long (60–120 × 8–12 μ) hyaline cystidia with slightly thickened walls are scattered over the surface. Pleurocystidia and cheilocystidia are abundant and similar. They measure 40–60 × 8–11 μ, have subcapitate apices and very slightly inflated midportions. The spores measure 3–4 × 2–2.5 μ, are broadly ellipsoid, and turn yellowish in iodine. The pileus and gill trama is also yellowish in iodine. The exterior of the stipe is clothed with cystidia similar to those found on the pileus.

COLLYBIA XUCHILENSIS Murrill.

The type consists of a very small fruit-body which is pale-brown and very fragile. The base is characterized by a white patch of mycelium. The pileus trama is homogeneous below a loose palisade of inflated pedicellate cells which are filled with a dark-brown content. The cells are clavate but a few have blunt elongated necks. The spores are 5–6.5 μ, globose, smooth and turn yellowish in iodine. The basidia are four-spored. Cystidia are scattered on and near the gill edges. They measure 36–40 × 10–18 μ, are almost ovoid or with an ovate pointed apex, hyaline and smooth. In some the apex is subpapillate.

GALERINA MYCENOIDES (Fries *sensu* Jaap) Kühner.

Gregarious to subcespitose under brush in swampy areas and along the borders of ponds, Lake Timagami, Ont., Aug. 27, 1936 (R. F. Cain & A. H. Smith, *4118*). Our collection is clearly the species Kühner (**6**) has described. I have never found a species of the " togularis group " of *Conocybe* on sphagnum. The diagnostic features of the Timagami collection are as follows:

Pileus 5–20 mm. broad, obtusely conic to convex, glabrous, striatulate, moist, " tawny " to " ochraceous tawny," hygrophanous, fading to ochraceous-buff; flesh fragile, thin, watery, no distinctive odor or taste; lamellae adnate, broad to moderately narrow, subdistant, pale ochraceous tawny, edge fimbriate to dentate, thin; stipe 2–4 cm. × 1–2.5 mm., concolorous with the pileus or paler honey color, tawny to reddish-brown below, watery, glabrous ex-

cept for a superior white fibrillose annular zone (submembranous at times), tubular; spores 12–14 × 6–8 μ, slightly roughened, subamygdaliform; cystidia on edge only, 38–50 × 9–16 μ, fusoid ventricose or variously contorted above a somewhat inflated base; pileus trama homogeneous; basidia four-spored.

GALERINA STAGNINA (Fries) Kühner.

Kühner (**6**) states that this is a very rare species in Europe, and, although I have been searching for it in North America since 1929, it was not discovered until this past season. The specimens were found in a damp mossy stream bed on sphagnum and other mosses near Lake Timagami, Ontario, Sept. 6, 1936 (*4595*). The pellicle of the pileus is composed of a very thin layer of narrow subgelatinous hyphae, and the species is thus a typical *Galerina.* The spores measure 13–16 × 7–9 μ on some pilei and 15–18 × 8–10 μ on others, but are as Favre [in Kühner (**6**)] described them in all other respects. The pilei measured 10–25 mm. broad, the stipes 8–15 cm. long and 2–4 mm. thick. The pilei were "russet" at first but soon faded to "clay color" or sordid buff. The white fibrillose patches left on the margin by the veil soon disappear. The stipes are often enlarged below, and more or less undulate over all. The color is the same or darker than that of the pileus.

HEBELOMA SPOLIATUM (Fries) Gillet *sensu* Bresadola.

Pileus 2.5–5 cm. broad, convex or obtusely umbonate, plane or broadly convex in age, viscid, opaque, glabrous, "army brown" to "tawny," fading to "pale vinaceous buff," margin inrolled and whitish at first; flesh thick and cartilaginous, pale or dark watery-brown, odor and taste none; lamellae close, narrow, rounded adnate or in age rather broad and adnexed, pallid becoming "avellaneous" or brighter at maturity; stipe 6–9 cm. × 3–9 mm., pliant but tough, equal or tapering downward, tubular, whitish to pallid above, darker below (near "bistre" at times), longitudinally appressed silky, in age often somewhat twisted striate; veil none; pileus trama homogeneous beneath a thick gelatinous pellicle; cheilocystidia 30–35 × 8–10 μ, cylindric to clavate or the mid-portion slightly inflated, pleurocystidia not differentiated; basidia four-spored; spores 7–10 × 4–5 μ, nearly smooth.

Gregarious under spruce, Lake Tahkenitch, Ore., Nov. 11, 1935 (*3430*). This species resembles *Naucoria lubriciceps* Kauff. &

Smith in stature but is readily distinguished by the gelatinous pellicle over the surface of the pileus. The above collection represents the form figured by Fries (**3**) and Bresadola (**1**). Ricken (**13**) and others, including Fries himself, described the species as having a long pseudorhiza.

Hebeloma sporadicum sp. nov. (FIG. 1, *p;* 4).

Pileus convexus, demum planus, viscidus vel glutinosus, glabrus, sordide albidus vel pallide ochraceus, margine involutus et saepe maculatus; caro albida, firma, inodora; lamellae confertae, latae, adnexae, gutulatae; stipes 4–8 (10) cm. longus, 1–2 cm. crassus, solidus, albidus, apice guttulatus, subglabrus; sporae 9–12 × 5–6.5 μ; cheilocystidia 50–70 × 8–10 μ. Specimen typicum legit A. H. Smith n. *5050* prope Ann Arbor, Mich., Oct. 7, 1935, in Herb. Univ. of Mich. conservatum.

Pileus 5–10 (13) cm. broad, convex, remaining broadly convex or becoming plane, at times the margin wavy and elevated slightly, viscid in dry weather, glutinous after rains, in age sometimes only subviscid, " pale ochraceous buff " to " pinkish buff " or appearing whitish, becoming darker at maturity, disk " cinnamon buff," " avellaneous " or " tawny olive," the margin remaining whitish or at times with dark honey colored zones or spots, margin long remaining inrolled and pruinose; flesh white, thick, firm, odor and taste not distinctive; lamellae close, narrow to moderately broad in large specimens (8–12 mm.), adnexed, beaded with drops of moisture until near maturity, pure white, becoming " wood brown " as the spores mature, edge white crenulate at first, deeply eroded in age; stipe 4–8 (10) cm. long, 1–2 cm. thick, equal, solid, pure white, base sordid brownish in age, lower portion silky, upper portion pruinose at first, upper half or two thirds more or less scaly in age because of the breaking up of the cuticle, usually beaded with drops of moisture at the apex; veil lacking; pileus trama homogeneous below a gelatinous pellicle; cheilocystidia 50–70 × 8–10 μ, clavate above an elongated basal portion, thin walled; basidia four-spored; spores 9–12 × 5–6.5 μ, somewhat almond shaped, smooth or very slightly roughened.

In arcs under spruce, Ann Arbor, Mich., Aug. 10, 1925, C. H. Kauffman, again in the same locality Oct. 1 (*4977*) and Oct. 7, 1936 (*5050*-type). The lack of a veil, the beads of moisture on the gills and stipe, the slightly roughened spores, the robust stature and scaly stem, the very pale colors and the occasionally spotted or zoned pilei distinguish the species. The gill characters vary a great deal, but the deeply eroded edges are characteristic of mature

specimens. *Hebeloma crustuliniforme* is close but is consistently described by European investigators as having a strong odor. It differs from *H. crustuliniforme* sensu Kauffman (**4**) in its paler colors as well as lack of an odor. Hundreds of fruit-bodies were

FIG. 4.

examined in all stages of development and no odor was detected. *H. sporadicum* has the stature and scaly stipe of *H. sinapizans* but the colors of the latter, its rougher spores and odor distinguish it. The spores of *H. sporadicum* appear almost smooth when fresh, but after drying and remoistening in KOH the outer coat remains quite wrinkled.

MARASMIUS PUTILUS Fries.

Pileus 2–4 cm. broad, convex, expanding, varying from obtuse to subdepressed on the disk, even at first, margin soon becoming short striatulate, glabrous, lubricous and glistening when wet, "chestnut brown" to "carob brown" becoming "sayal brown" when faded; flesh concolorous with the surface, rather thick on the disk, thin near the margin, odor not distinctive, taste mild or slowly bitterish; lamellae close to subdistant, adnate, seceding, rather narrow, often venose connected and crisped, pale cinnamon or darker when fresh, dingy and pallid incarnate cinnamon in age, edge entire, occasionally becoming serrulate in age; stipe 3–6 cm. long, 2–4 mm. diam., equal or enlarged below, densely white villose tomentose over the lower portion or sometimes nearly to the apex, tinged reddish-brown to purplish beneath the white covering, with

a short pseudorhiza, tough, hollow; spores 7–9 × 3–4 μ; cystidia not differentiated; pileus trama homogeneous.

Gregarious under pine at Saginaw Forest, Ann Arbor, Mich. This is a common species in the fall in this one locality, but I have not found it anywhere else. The white tomentose stipe is a conspicuous and constant character. Lange (**9**) has given a good illustration of it.

OMPHALIA BAKERI Murrill.

A study of the microscopic characters of the type shows it to be identical with *Mycena latifolia* (Peck) Sacc. The spores measure 6–8 × 3–4 μ, are smooth, ellipsoid, and turn pale bluish-gray in iodine. The basidia are four-spored. Cystidia are abundant on the edges and scattered on the sides of the gills. They measure 40–60 × 9–14 μ, and are fusoid ventricose with the wall of the inflated part roughened by short obtuse protuberances. Cystidia with roughened walls are much more numerous on the edge than on the sides of the gills. In addition, Murrill's specimens compare very well with dried material of *M. latifolia* macroscopically. The collection reported by Kauffman (**5**) appears to be a mixture of this and another species. Certain of his specimens have cystidia similar to those found in Murrill's type.

Omphalia orickiana sp. nov. (FIG. 2, *c*).

Pileus 10–25 mm. latus, convexus demum planus vel umbilicatus, subudus, minute fibrillosus vel subglabrus, unicolorus, vinaceobrunneus, cartilaginus, haud hygrophanus, margine incurvatus; lamellae confertae, angustae, breviter decurentes, pallide griseovinaceae demum vinaceobrunneae; stipes 1–3 (4) cm. longus, 1.5–2 mm. crassus, cartilaginus, deorsum attenuatus, basi fulvotomentosus, pileo concolor; sporae 4.5–6 × 2.5–3 μ, levae, ellipsoideae; cheilocystidia et pleurocystidia 25–40 × 8–14 μ, fusoide ventricosa vel subcylindrica. Specimen typicum legit A. H. Smith n. *3762* prope Orick, Calif., Dec. 4, 1935, in Herb. Univ. of Michigan conservatum.

Pileus 10–25 mm. broad, convex, umbilicate or the margin plane and the disk depressed, at times broadly infundibuliform with a wavy or subcrenate margin, surface moist to dry, faintly innately fibrillose (under a lens), fibrils more numerous around the disk and scattered near the margin, color evenly "dark vinaceous brown," margin incurved at first and at times faintly striatulate; flesh thin, hardly tapering toward the margin, "dark vinaceous brown," pliant and cartilaginous, odor and taste not distinctive,

lamellae narrow, crowded, short decurrent, edge even, at first "pale grayish vinaceous," becoming darker and near "sorghum brown" at maturity; stipe 1–3 (4) cm. × 1.5–2 mm., apex usually enlarged, base often attenuated, surface tawny tomentose below, minutely pruinose above, concolorous with the pileus or darker, tubular; spores 4.5–6 × 2–3 μ, smooth, ellipsoid, pale-bluish in iodine; cystidia scattered on sides and edge of gills, 24–37 × 8–14 μ, nearly cylindric and with obtuse apices or (usually on the edge) broadly fusoid-ventricose; pileus trama with a very thin pellicle, a region of pseudoparenchymatous tissue beneath it, the remainder floccose but compact.

Cespitose to gregarious on redwood logs, Orick, Calif., Dec. 4, 1935 (*3762*-type). This species is similar to *O. campanella* in consistency and manner of growth but the margin of the pileus is definitely incurved and the colors separate it at once. The walls of the cells in the gill and pileus trama are brown in water mounts but change to haematite red in KOH. In spite of the cartilaginous consistency, the fruit-bodies do not revive well, which excludes the species from *Marasmius*.

OMPHALIA ACUMINATA Murrill (FIG. 2, *g*).

The type consists of a small group of well preserved fruit-bodies. The dried pilei are pale ochraceous-brown and rather firm in consistency. The pileus trama is homogeneous in section with a thin pellicle over the surface. The gill trama is homogeneous and not otherwise distinctive. Pleurocystidia and cheilocystidia are abundant on the gills, they are hyaline, smooth, broadly fusoid, somewhat obtuse and measure 40–60 × 8–14 μ. The basidia are four-spored. The spores measure 7–9 × 5–6 μ and are dark rusty-brown under the microscope. They are characterized by a thick wrinkled almost hyaline exospore and a thin dark brown endospore. The small conic pilei and stature suggest a relationship with *Galerina triscopoda* (Fries) Kühner, but the consistency of the revived specimens is more cartilaginous than in the latter. The extreme development of the wrinkled exospore is striking and also indicates a relationship with species of *Galerina*. Since Murrill's published description contradicts the spore characters of the type, it is highly desirable to obtain fresh material of the above brown spored fungus in order to check the characters of the fresh

fruit-bodies. Since the type establishes the species, it is necessary to place the fungus in a genus of ochre-brown spored fungi, and since it is obviously closely related to species of *Galerina*, the combination **Galerina acuminata** (Murrill) comb. nov. is proposed.

OMPHALIA MCMURPHYI Murrill.

Two bright brown fruit-bodies constitute the type. The spores of one measure 10–12 × 6–7 μ, have a slightly wrinkled outer wall and are ochraceous tawny under the microscope. The basidia of this cap are two-spored and the cystidia were not sharply differentiated. The sterile cells on the gill edges are basidia-like or slightly larger. The pileus trama did not revive well but appeared homogeneous. The spores of the other fruit-body were hyaline under the microscope in KOH, and remained hyaline in iodine. They were smooth and measured 12–16 × 7–8 μ. The basidia are four-spored and the pileus trama homogeneous. No differentiated cystidia were seen. The specimen with the hyaline spores is to be regarded as the type and therefore the specimen to which the name must be applied. The large spores should aid materially in recognizing the species.

PSILOCYBE CORNEIPES (Fries) Sacc. (FIG. 2, *b, d, f*).

Pileus 1–3 cm. broad, obtusely conic, campanulate to conic umbonate with the margin plane, glabrous and polished, moist, "apricot orange" when young, becoming evenly "ochraceous tawny" with a striate margin, hygrophanous, fading first on the disk, becoming "zinc orange," in age finally "ochraceous buff," margin strongly inrolled at first; flesh yellowish, firm, odor and taste not distinctive; lamellae close, broad, rounded adnate and soon seceding, "cartridge buff" at first, soon sordid grayish brown, edge whitish; stipe 3–5 cm. × 1.5–2 mm., equal or slightly enlarged above, strigose with dull tawny orange hairs at the base, glabrous and horny above, pale-orange to yellowish at the apex, dark reddish-brown to blackish below, apex faintly pruinose; spores 6–7 × 4–5 μ, near "benzo brown" in mass or with a more reddish tinge, nearly hyaline under the microscope (similar to spores of *Psilocybe connisans* Peck), furnished with a hyaline germ pore, ellipsoid or slightly ventricose; basidia four-spored; cystidia abundant on sides and edges of the lamellae, 60–75 × 10–18 μ, fusoid ventricose, thick walled, apex occasionally incrusted; pileus trama homogeneous.

Gregarious on swampy ground under Alnus, Lake Timagami, Ont., Sept. 2 (*4443*) and Sept. 12, 1936 (*4845*). This seems to be an exceptionally rare species. My specimens agree well with the description and illustration of Fries (**2**) (**3**). The spores and cystidia resemble those of such American species as *P. connisans* and *P. camptopoda* Peck. In stature, color and consistency it resembles *Naucoria cidaris* (Fries) Quél. The latter has spores which are nearly hyaline under the microscope but much smaller and no characteristic cystidia are present.

STROPHARIA PSATHYROIDES Lang.

Pileus 1–2 (3) cm. broad, obtusely conic, campanulate or expanded umbonate, chocolate-brown and striatulate when moist, hygrophanous, fading to " cinnamon buff " or pale livid buff, the disk often remaining tawny, atomate and somewhat rugulose when faded, at first with delicate fibrillose patches on or near the margin, soon glabrous; flesh thin and very fragile, odor and taste not distinctive; lamellae moderately close, ascending adnate, broad, pallid, becoming dull purplish brown, thin, edge white fimbriate; stipe 8–11 cm. $\times$ 2–5 mm., equal, tubular, fragile, pale cinnamon-buff or whitish, becoming darker below, sparsely covered by loose fibrils or glabrous in age, often somewhat undulate; annulus submembranous, superior, flaring, whitish; spores 8–10 $\times$ 4–5 μ; basidia four-spored; cystidia 42–60 $\times$ 10–20 μ, scattered on the sides and edges, broadly fusoid ventricose; pileus trama corticated by a palisade of pyriform pedicellate cells (as in species of *Conocybe*).

Singly or scattered on sphagnum, Catlin Lake, Adirondack Mts., New York, Aug. 13, 1934 (*208*); Ko Ko Ko Bay, Lake Timagami, Ont., Aug. 28, 1936 (*4254*, R. F. Cain & A. H. Smith); and Mud Lake Bog, Washtenaw Co., Mich., Oct. 20, 1936 (*6122*). This is apparently a rare but widely distributed species. Lang has reported it from Oregon. The hymeniform cuticle of the pileus is deserving of notice. Most species of *Psathyra* and also those in the section *Sphintrigera* of *Stropharia* are characterized by a cuticle made up of large isodiametric cells. These cells usually form a region several cells deep over the cap surface instead of a palisade which is one cell deep. Clavate or pear-shaped cells may be more or less scattered throughout this region, but if so, they are not organized into a palisade.

TRICHOLOMA PLATYPHYLLUM Murrill.

Lake Quiniault, Wash., Oct. 6, 1935 (C. H. Kauffman); gregarious under fir, Olympic Hot Springs, Olympic Mts., Wash., Oct. 19 (*3254*); under dense stands of pine, Big Creek, Lincoln Co., Ore., Nov. 6 (Smith & Zeller, *3963*) and Lake Tahkenitch, Ore., Nov. 11, 1935 (*3420*). In his description Murrill does not mention either taste or odor and describes the spores as $8.5 \times 6\ \mu$. The spores of the type however measure 9–11 (12) $\times$ 6–7.5 (8) μ. The spore size in all the collections cited above corresponds to my observations on the type. In deposits they consistently measured $10\text{–}12 \times 6.5\text{–}8\ \mu$. My specimens were compared with the type macroscopically also, and agree with it in all important characters such as pale color, stature and broad distant gills. The gill and pileus trama is yellowish in iodine but the spores turn yellowish-brown and in my own collections there is a tendency for the basidia to turn slightly brownish, but not as dark as in *Collybia sinuata*. The difference is quantitative rather than qualitative however. In all of the fresh material which I collected during 1935 the odor and taste were distinctive. Although the odor was weaker in specimens which had been frozen, it was nevertheless characteristic. It resembles that of *Tricholoma sulfureum* (Fries) Quél. Since the type appears to be a somewhat overmature specimen, it is likely that its odor was overlooked at the time Murrill studied it. The species is very similar to *Tricholoma inamoenum* (Fries) Gillet. If the European species consistently has the small spores attributed to it by Lange (**8**) and Konrad and Maublanc (**7**), Murrill's species should be classed as a variety of it.

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EXPLANATION OF FIGURES

FIG. 1. *Collybia albipilata* Peck. *f*, clavate cells and a cystidium from the hymeniform layer covering the pileus × 750; *i*, cystidia from the upper part of the stipe × 750; *h*, *j* & *k*, pleurocystidia × 750. *Collybia cinchonensis* Murrill. *l*, spores × 1500; *m*, pleurocystidia × 750. *Collybia domestica* Murrill. *n*, hyphal filaments covering the pileus surface × 750; *o*, spores × 1500. *Collybia Glatfelteri* Murrill. *a*, clavate cells from the hymeniform layer covering the pileus × 750; *e*, spores × 1500. *Collybia ludoviciana* Murrill. *c*, clavate cells from the hymeniform layer covering the pileus × 750; *g*, spores × 1500. *Collybia strictipes* Peck. *b*, clavate cells from the hymeniform layer covering the pileus × 750; *d*, spores × 1500. *Hebeloma sporadicum* Smith. *p*, spores × 750.

FIG. 2. *Collybia Glatfelteri* Murrill. *a*, pleurocystidia × 750. *Collybia marasmiïformis* Murrill. *e*, four yellow cells from the pileus trama × 750. *Galerina acuminata* (Murrill) Smith. *g*, spores × 1650. *Psilocybe cornecipes* (Fries) Sacc. *b*, cheilocystidia × 750; *d*, three pleurocystidia × 750; *f*, five spores × 1500.

FIG. 3. *Collybia marasmiïformis* Murrill. *e*, two pleurocystidia × 750; *h*, five cheilocystidia × 750; *i*, an enlarged yellow cell from the stipe tissue × 750. *Collybia setulosa* Murrill. *a*, cells from the cuticle of the pileus with one seta at the right ×450. The setae arise from deep in the pileus trama; *b*, setae from the stipe × 450; *c*, spores × 1500; *g*, pleurocystidia × 750. *Collybia trullisata* Murrill. *d*, *cystidia* from the pileus surface × 750; *f*, pleurocystidia × 750.

FIG. 4. *Hebeloma sporadicum* Smith. × 1.

TWO UNUSUAL RUSTS OF GRASSES [1]

E. B. Mains

(with 1 figure)

In 1934, the genus *Angiopsora* was proposed (**4**) for a group of rusts with catenulate teliospores in crusts on grasses. Among the species transferred from *Puccinia* was *Puccinia pallescens.* This species was listed by Arthur and Fromme (**1**) on *Tripsacum latifolium* Hitch. and *T. lanceolatum* Rupr. from Mexico, Guatemala, Nicaragua and Salvador and on *Zea Mays* L. from Puerto Rico. As has already been pointed out (**4**) only uredinia have been known for the rust on maize. The urediniospores on this host were much larger than those on species of *Tripsacum.* Consequently the specific identity of the rust of maize was questioned.

Recently a specimen of the maize rust collected by Mr. J. R. Johnston in Guatemala was received from Dr. George B. Cummins. Associated with the uredinia were well developed telia characteristic of the genus *Angiopsora* (fig. 1, *A*). These also were found to differ from the telia of *Angiopsora pallescens* in several important respects and the rust of maize is consequently considered an unnamed species for which the following name is proposed:

Angiopsora Zeae sp. nov. (fig. 1, *A*).

Urediniis amphigenis, 0.3–1.0 mm., subepidermalibus, diu tectis, pallide luteus; urediniosporis sessilibus, obovoideis vel ellipsoideis, 16–20 × 22–34 μ, membrana 1.5–2 μ, echinulatis; poris inconspicuis.

Teliis hypophyllis, 0.5 mm., atro-brunneis, aggregatis in orbiculatas maculas, 2–3 mm. latas; teliosporis in catenas, variabilibus, angulatim ellipsoideis vel oblongis, 12–18 × 16–38 μ, flavo-brunneis, membrana 1.5–2 μ, ad apicem 3 μ.

In foliis *Zeae Maydis.* Legit J. R. Johnston, Alameda, Guatemala, Nov. 2, 1936. Specimen typicum in Herb. Univ. Mich. conservatum.

Uredinia amphigenous, mostly epiphyllous, 0.3–1.0 mm. pale yellow, subepidermal, covered by the overarching epidermis except

[1] Papers of the Department of Botany and Herbarium of the University of Michigan No. 635.

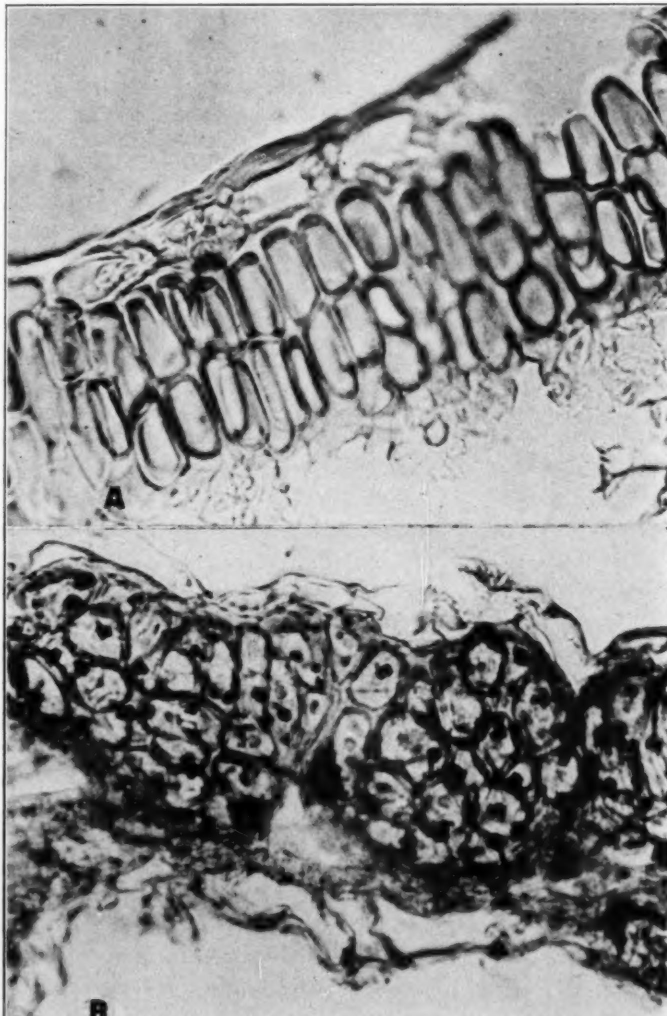

FIG. 1. *A*, section through a telium of *Angiopsora Zeae* showing catenulate arrangement of teliospores. × 500; *B*, section through a telium of *Phakopsora apoda* showing irregular arrangement of teliospores. × 500.

for a small pore or slit; urediniospores sessile, obovoid or ellipsoid, 16–20 × 22–34 μ; the wall colorless or yellowish, 1.5–2 μ, moderately echinulate, the pores obscure.

Telia mostly hypophyllous, 0.5 mm. wide, usually encircling the uredinia in circles 2–3 mm. across, up to 60 μ thick, subepidermal, dark chocolate-brown, long covered by the epidermis; teliospores catenulate in rows of 1–3 usually 2, angularly ellipsoid or oblong, 12–18 × 16–38 μ, the wall golden brown 1.5–2 μ, at the apex of the uppermost spore up to 3 μ.

Zea Mays L. Alameda, Guatemala, J. R. Johnston, Nov. 2, 1936 (type); also reported from Puerto Rico and Trinidad.

A study of specimens of *Angiopsora pallescens* on *Tripsacum* kindly loaned from the Arthur Herbarium shows that it differs from *A. Zeae* in the following respects. The uredinia are smaller and the urediniospores measure 12–16 × 16–25 μ. The teliospores are smaller, 10–16 × 10–26 μ. There are 1–4 teliospores in a chain usually 2–3 forming telia slightly thicker than those of *A. Zeae*. In these respects *A. Zeae* resembles more closely *A. lenticularis* Mains. The latter species has been collected only on species of *Lasiacis*. It has smaller uredinia and telia than *A. Zeae*. Also the telia of *A. lenticularis* coalesce in elongated areas 3–15 mm. long and 1–3 mm. broad.

Angiopsora Zeae is easily distinguished macroscopically from the widespread rust of maize, *Puccinia Sorghi*. The latter has brown very pulverulent uredinia while those of *A. Zeae* are light yellow and mostly covered by the epidermis. The telia of *Puccinia Sorghi* are usually naked with conspicuous ruptured epidermis, while those of *A. Zeae* remain covered by the epidermis. As contrasted with *Puccinia Sorghi* which has been distributed throughout the world along with its host, *Angiopsora Zeae* apparently has a very limited distribution in the Caribbean region.

The genus *Angiopsora* was distinguished from *Phakopsora* principally on account of the catenulate arrangement of the teliospores (**4**). These develop in short vertical rows of two or more. As Dietel (**2**) has emphasized *Phakopsora* forms a compact crust in which the teliospores are irregularly arranged. Apparently the younger teliospores are forced in between the older. In this connection, a specimen received from Dr. George B. Cummins has proved to be very interesting. This is the type of *Puccinia apoda*

Har. & Pat. (Vestergren, Micromycetes rariores selecti *1565*). Hariot and Patouillard (**3**) described the teliospores as sessile or shortly pedicillate, mostly one-celled, some two-celled. The teliospores prove to be one-celled, without pedicels. They are not in vertical rows but are irregularly arranged (FIG. 1, *B*). The urediniospores are apparently sessile and are produced in uredinia which are bordered by paraphyses which are united below. This species therefore apparently belongs to the Melampsoraceae and in the genus *Phakopsora*. The host is given as *Pennisetum setosum*. This is, therefore, the first record of a species of *Phakopsora* on a grass. The following is a revised description of the species:

Phakopsora apoda (Har. & Pat.) comb. nov.

Puccinia apoda Har. & Pat. Bull. Mus. Hist. Nat. Paris **15**: 199. 1909.

Uredinia scattered, chestnut-brown, small; paraphyses abundant, peripheral, united below, incurved, 8–10 × 40–60 μ, chestnut-brown, the wall irregularly thickened, up to 8 μ on the convex side; urediniospores broadly ellipsoid or obovoid, 20–24 × 24–26 μ, the wall colorless or yellowish, 1.5–2 μ, closely verrucose-echinulate, the pores obscure.

Telia amphigenous, coalescing in groups 0.5–2.0 mm. across, dark chocolate-brown, long covered by the epidermis, forming crusts 50–100 μ thick occupying most of the tissue between the upper and lower epidermis; teliospores unicellular, irregularly arranged and compressed into various shapes, 13–20 × 14–30 μ, the wall golden-brown, 1.5–2 μ, up to 4 at the apices of the uppermost spores, apparently surrounded by a thin gelatinous layer.

On *Pennisetum setosum*, Fort Lamy, Chari, French Congo, Oct. 1903. A. Chevalier.

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THE PERFECT STAGE OF CATINULA TURGIDA [1]

J. Walton Groves [2]

(with 8 figures)

Catinula turgida (Fries) Desm. is a common conidial fungus occurring on twigs of *Corylus*, and although it has been known for a long time, its connection with a perfect stage has never been established. During the summer of 1934 in the Temagami Forest Reserve, Ontario, it was found associated with a small, inconspicuous *Pezicula*, which is believed to be undescribed, and cultural studies have shown that this is the perfect stage. It is the purpose of this paper to describe the *Pezicula* and report the genetic connection of the two stages.

Fries (**1822**) described a fungus occurring on twigs of *Corylus* as *Excipula turgida*. There is some doubt if this was the fungus under consideration here, because in Fries' classification the genus *Excipula* was treated as a sub-genus of *Cenangium* and was evidently intended as a discomycetous genus, whereas *Catinula turgida* is an imperfect fungus. The incomplete description might well apply to a small discomycete, but it might also well apply to *Catinula turgida* which, without microscopic examination, could readily be mistaken for a small apothecium, especially in wet weather. The notes given by Fries in addition to the description; " Sparsa, minuta, margine erecto. Junior Sphaeriam, aperta disco turgido instructo *Sphaeronema* refert " would seem to apply well to *Catinula turgida*. It seems probable that Fries mistook the fungus for a small discomycete.

Diehl and Cash (**1929**) have pointed out that *Cenangium*

[1] Contribution from the Department of Botany, University of Toronto, Toronto, Ontario.

[2] The writer wishes to express his thanks to Professor H. S. Jackson, under whose direction the work was carried on, for his continued interest and helpful criticisms; and to Mr. J. Herbert Stewart of the Department of Classics, Oakwood Collegiate Institute, Toronto, who assisted with the Latin diagnosis.

turgidum (Fries) Duby, a combination based on *Excipula turgida* Fries, must not be confused with *Cenangium turgidum* Fries, a very different fungus and a true discomycete occurring on oak.

Desmazières (**1852**) gave a much more complete description and proposed the combination *Catinula turgida,* by which name the fungus has been generally known.

Von Höhnel recognized that it showed no relationship to the type species of *Catinula* and transferred it first to *Dothichiza* (**1909**), and later to *Psilospora* (**1915**). He was of the opinion that Desmazières had not proved his fungus to be the same as that described by Fries, and that *Excipula turgida* Fries was probably a discomycete. Von Höhnel had examined Desmazières' specimens but not those of Fries, and the identity of the two forms could only be decided by an examination of Fries' specimens.

Nannfeldt (**1932**) considered that the imperfect stages of *Pezicula* species, with a few exceptions, belonged in the genus *Cryptosporiopsis* Bubak and Kabat (**1912**), a conclusion which has been supported by the writer's cultural studies in this group. The fruiting body of *Catinula turgida* is a little more conspicuous and a little more definite in form (FIG. 2) than many other species of *Cryptosporiopsis,* but the microscopic structure, the oblong-ellipsoid conidia, and its connection with a *Pezicula* all provide evidence that its real relationships are with the genus *Cryptosporiopsis* in the system of the fungi imperfecti.

In Saccardo's Sylloge Fungorum **3**: 673, and **8**: 559, it is stated that *Catinula turgida* is the imperfect stage of *Cenangium Coryli* Corda. The genus *Cenangium* has been used to include a great number of diverse and unrelated species and it has not been possible to examine any specimens of *Cenangium Coryli.* However, two features in its description, the blackish disc and ascospores 9–10 μ long, would seem to definitely exclude the possibility of its being identical with the *Pezicula* described in this paper, which has been demonstrated as the perfect stage of the *Catinula* by cultural methods.

Pezicula corylina sp. nov.

Excipula turgida Fries, Syst. Myc. **2**: 189. 1822.

Cenangium turgidum Duby, Bot. Gall. **2**: 736. 1830 (not *C. turgidum* Fries).

Catinula turgida Desm., Ann. Sci. Nat. III. **18**: *374*. 1852.
Sphaeronema Coryli Peck, Ann. Rep. N. Y. St. Mus. **24**: 85. 1872.
Dothichiza turgida v. Höhn. Fragm. Myk. *341*. 1909.
Psilospora turgida v. Höhn. Fragm. Myk. *913*. 1915.

Apotheciis erumpentibus, dispersis vel seriatim instructis, solitariis vel caespitosis, sessilibus, ad basim leviter attenuatis, orbicularibus vel pressione inter se distortis, minutis, 0.2–0.5 mm. diam., 0.2–0.4 mm. altis, luteolis,

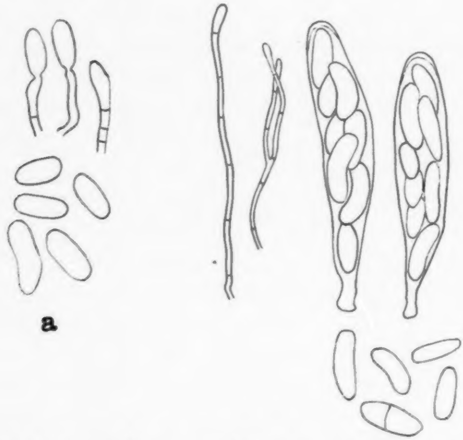

FIG. 1. *Pezicula corylina*. *a*, conidiophores and conidia; *b*, asci, ascospores, and paraphyses. Drawn with the aid of a camera lucida. × 400.

in sicco leviter pruinosis, mollibus, ceraceis, in humido carnosis; hymenio plano vel convexo, leviter pruinoso, margine primum pallide, dein evanescente; hypothecio pseudoparenchymato; ascis cylindraceo-clavatis, octosporis, raro tetrasporis, 85–125 × 15–20 μ; ascosporis elliptico-oblongis, hyalinis, rectis vel leviter curvatis, continuis vel uniseptatis, 15–27.5 × 6.5–10.0 μ; paraphysibus hyalinis, filiformibus, septatis, simplicibus vel ramosis, 2.0–2.5 μ diam., apice ad 3–5 μ incrassatis, leve epithecium formantibus.

Apothecia erumpent, scattered or more or less in rows, separate or caespitose, circular, sometimes crowded, sessile, narrowed below, pale yellow, slightly pruinose when dry, much brighter when moist, close to sulphur yellow, minute, 0.2–0.5 mm. in diameter, 0.2–0.4 mm. in height, soft, waxy in consistency, more fleshy when moist; hymenium at first concave, then plane to convex, slightly pruinose, pale yellow to slightly reddish, margin at first forming a delicate

lighter border, later disappearing; tissue of the hypothecium compact, pseudoparenchymatous, composed of thick walled cells 5–12 μ in diameter, hyaline or sometimes brownish near the base, arranged in more or less vertically parallel rows, curving obliquely toward the outside, the cells more elongated in the upper central part; subhymenium narrow, compact, composed of closely interwoven,

FIG. 2. Photograph of a freehand section of a fruiting body of *Catinula turgida*. × 43; 3, photograph of a freehand section of a fruiting body of *Cryptosporiopsis grisea* from Krieg. Fung. Sax. 2445. × 43.

slender hyphae; asci cylindric-clavate, short stalked, eight spored, occasionally four spored, 85–125 × 15–20 μ; ascospores oblong-ellipsoid, hyaline, straight or slightly curved, one or two celled, irregularly biseriate, 15–27.5 × 6.5–10.0 μ; paraphyses hyaline, filiform, simple or branched, septate, 2.0–2.5 μ in diameter, the tips swollen to 3–5 μ, forming a slight epithecium.

TYPE: University of Toronto Herbarium *7981*. On *Corylus rostrata*, Bear Island, Temagami Forest Reserve, Ontario, July 20, 1935. J. W. Groves.

SPECIMENS EXAMINED: University of Toronto Herbarium. On *Corylus rostrata*. *6941* (*219*),[3] *6942* (*211*), *6944* (*226*), *7978*, *7980* (*456*), *7981* (*311*), Temagami Forest Reserve, Ontario.

Conidial fruiting bodies erumpent, thickly scattered or more or less in rows, mostly separate, sometimes two or three together, cylindric to cylindric-conic, or compressed when dry and subhysteriform, opening out widely when moist, 0.2–0.5 mm. in diameter, 0.3–0.5 mm. in height, black or dark olivaceous, hard, brittle, fleshy-leathery when moist; basal stroma 40–100 μ in thickness, pseudoparenchymatous, composed of hyaline cells 5–10 μ in

[3] The numbers in brackets refer to duplicate collections in the writer's herbarium.

diameter, containing a single, simple or slightly lobed cavity, the walls of the cavity 40–75 μ in thickness, the cells thicker walled, darker, and becoming more elongated than in the basal stroma, the upper part consisting of more or less parallel, brownish hyphae about 3 μ in diameter, the ends often projecting loosely around the opening; conidiophores cylindric to conical, hyaline, septate, occasionally branched, sometimes swollen below the point of attachment of the spore, $10–40 \times 2.5–5.0\ \mu$; conidia borne terminally, oblong-ellipsoid, hyaline, one celled, straight or sometimes slightly curved, ends rounded, one end with a truncate apiculus, $17–27.5 \times 8.0–10.5\ \mu$; microconidia have not been observed.

EXSICCATI: Rel. Farl. *106* (as *Cenangium turgidum* Fries); Ellis N. Am. Fungi *949;* Kr. Fung. Sax. *1499.*

SPECIMENS EXAMINED: University of Toronto Herbarium. On *Corylus rostrata. 1312, 3223, 3459, 4033, 4435, 5952, 5953, 7978, 7979, 8441,* Temagami Forest Reserve, Ontario—*4536* (*78*), *7178,* Toronto, Ontario—*5555,* Bell's lake, Parry Sound, Ontario.

Cultures were made from both ascospores and conidia, and were grown on two per cent malt extract agar and on sterilized twigs of the host. The cultural characters were similar in both ascospore and conidial cultures and the conidial stage was produced in both.

On malt extract agar the colonies were slow growing, reaching a diameter of 2–3 cm. in a month, with a narrow, whitish, closely appressed margin, shading abruptly to very dark green or almost black. The surface was smooth or sometimes slightly radially furrowed, covered with a short, gray-green, downy to velvety, aerial mycelium, even or slightly tufted. The conidial fruiting bodies were usually abundant as small, fleshy-leathery stromata, at first rounded, then becoming more or less cylindric to cylindric-conic, opening at the top and spreading out widely, sometimes becoming dish shaped, about the same size as in nature or slightly smaller, usually covered externally with a short, gray-green tomentum. The tissue structure was similar to that found in nature, or sometimes with the cells more elongated and interwoven. The conidia and conidiophores were typical.

The twig cultures were prepared as described in an earlier paper, Groves (**1936**). On the twigs little aerial mycelium was produced except a few grayish-brown tufts around the point of inoculation. The conidial fruiting bodies were produced abundantly and were

FIGS. 4–8. 4, apothecia of *Pezicula corylina* with a few fruiting bodies of *Catinula turgida* present; 5, imperfect stage, *Catinula turgida;* 6, imperfect stage developed on a twig of *Corylus* in culture; 7, apothecia of *Pezicula Coryli* Tul. from specimen in Krieg. Fung. Sax. 2228; 8, specimen of *Myxosporium griseum* in Krieg. Fung. Sax. 2445. All × 4 approx.

very similar to those found in nature, showing a little more variation in size, 0.2–1.0 mm. in diameter, and usually covered with a short, gray-green tomentum. The microscopic features agreed with the fruiting bodies found in nature.

The perfect stage did not appear in any of the cultures, but inasmuch as the cultures from ascospores and conidia were similar and both produced the same conidial stage, it is concluded that the two stages are genetically connected. The apothecial stage has been referred to the genus *Pezicula* on the basis of the waxy-fleshy consistency, bright colour, and large, oblong-ellipsoid ascospores. In the imperfect stage the presence of oblong-ellipsoid conidia is generally typical of *Pezicula* species, and this is regarded as further evidence that *P. corylina* belongs in this genus.

Tulasne (**1865**) has described another *Pezicula* occurring on *Corylus* in Europe which he named *Pezicula Coryli,* but as far as is known, this species has not been reported in North America. With this *Pezicula* he found a conidial stage which he described but did not name, and claimed to have observed apothecia arising on the same stroma. The imperfect stage was described as *Myxosporium griseum* by Saccardo (**1884**), and later transferred to *Cryptosporiopsis* by Petrak (**1923**). A specimen labelled *Myxosporium griseum* in Krieg. Fung. Sax. *2445* and stated to be the imperfect stage of *Pezicula Coryli* Tul., has been examined and it agrees well with Tulasne's description but is quite different from *Catinula turgida.* It is, however, a similar type of conidial stroma (FIG. 3) to that which the writer has found in several other species of *Pezicula,* and which would be referred to the genus *Cryptosporiopsis* Bubak and Kabat. Therefore, there seems no reason to doubt that Tulasne was correct in his observations and that the imperfect stage of *Pezicula Coryli* is *Cryptosporiopsis grisea.*

The only specimen of *Pezicula Coryli* Tul. which has been available for comparison is that in Krieg. Fung. Sax. *2228.* In this specimen the apothecia are larger, more strongly erumpent, and less brightly coloured than *P. corylina,* resulting in a different general aspect, but the two species are quite similar in ascus and spore characters. It is concluded that there are two species of *Pezicula*

occurring on *Corylus* which may be difficult to separate in the apothecial stage, but have very distinct conidial stages.

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LIFE HISTORIES OF TWO LEAF-INHABITING FUNGI ON SYCAMORE

Frederick A. Wolf

(with 14 figures)

Leaf and twig blight of sycamore, *Platanus occidentalis* L., caused by *Gnomonia veneta* (Sacc. & Speg.) Kleb. is a widely prevalent disease. For a number of years it was assumed that this disease was the most common malady involving sycamore within the Duke Forest. During the past three years, however, my observations have indicated that this disease has been confused with another leaf blight disease, mainly caused by *Stigmina Platani* (Fuckel) Sacc., that is locally of considerably more consequence. Whilst studying this *Stigmina* disease it became apparent furthermore that the *Stigmina* leaf blight fungus is commonly associated with another pathogen, *Cercospora platanifolia* Ellis & Ev. Both *Stigmina Platani* and *Cercospora platanifolia* have long been known to mycologists, but as a result of the present study each has been found to possess a perithecial stage that matures in spring on decaying infected leaves. The life histories of these associated leaf-inhabiting fungi are therefore recorded at this time as a contribution to our knowledge of the diseases of sycamore.

Appearance of the Disease Complex.—Lesions induced by *Cerospora platanifolia* are first noted about mid-June, those by *Stigmina Platani* toward the close of July. In the case of the former very irregular, minute, brown, necrotic spots develop (fig. 14). They are sparse at first and about 1 mm. in diameter, but eventually several hundred lesions may appear on a single leaf. At this stage many of the spots will have fused.

Infection by *Stigmina* is first apparent by the presence of scattered, pale-green areas, if affected leaves are viewed from the upper leaf surface, the lower leaf surface of the corresponding areas being covered with a thin, weft-like, black coating (fig. 14).

By the time that the leaves are severely infected they may be entirely or largely pale green above and the entire lower surface may be covered with an effuse sooty film. By mid-August or early September extensive necrotic areas will have developed, the trees having the appearance of being affected with a severe leaf blight.

The lowermost leaves are the first to become diseased. Eventu-

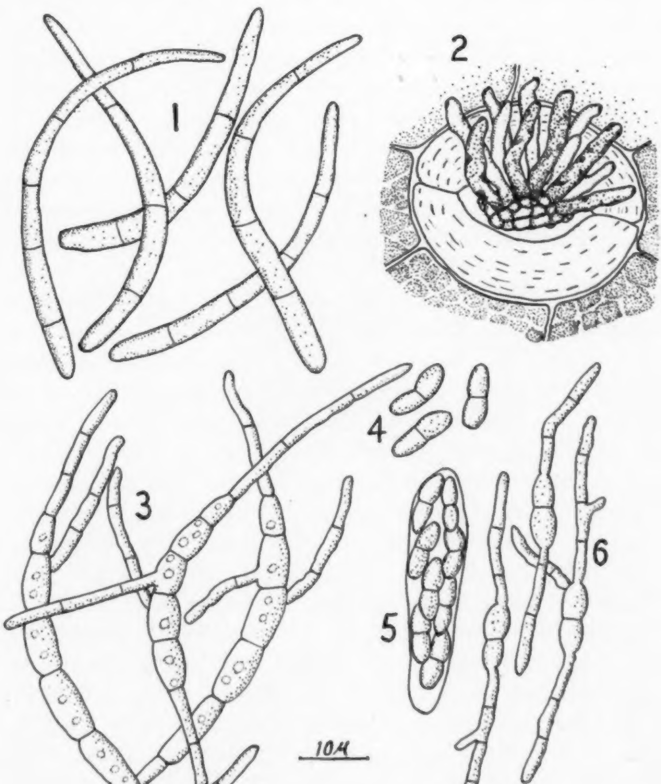

FIG. 1, conidia of *Cercospora platanifolia;* 2, conidiophore fascicle; 3, germination of conidia of *C. platanifolia* in malt agar; 4, ascospores of *Mycosphaerella platanifolia;* 5, ascus of *M. platanifolia;* 6, germinating ascospores.

ally all the foliage is involved. Affected trees are prematurely defoliated.

The Conidial Stages.—The fructifications of *Cercospora platanifolia* occur on both leaf surfaces on the small lesions. The tuberculate stromata from which the conidiophores arise occupy the stomatal openings. Each fascicle is comprised of 12–30 laxly-spreading conidiophores, 10–18 μ long (FIG. 2). The conidia are curved, clavate, 3–5-septate, and range from 30–60 × 3–4 μ (FIG. 1). The measurements for this species given by Ellis and Everhart (**4**) are 30–40 × 2–2.5 μ, a discrepancy in size that is probably due to their use of dried rather than fresh specimens.

After the leaves become invaded by *Stigmina Platani,* the fructifications of *Cercospora platanifolia* are largely hypophyllous and are widely interspersed among those of its associated pathogen. *Stigmina* is the more aggressive and as a result *Cercospora* is overrun and is largely masked by it.

In paraffin sections of lesions induced by *Stigmina Platani* the fascicles of conidiophores may also be observed to emerge from the stomata (FIG. 7). There is little stromatal tissue in young fascicles but gradually compact, brown stromata develop at the bases of the conidiophores. The conidia (FIG. 8) are brown, ovate to elongate-ovate, or broadly clavate, and vary from 15–40 × 8–10 μ. Most young conidia are ovate, about 20 μ long, and are 3-celled; old ones, however, possess additional septa, or the septation rarely is muriform, characteristic of the genus *Stigmella.*

In 1929, Apostolides (**1**) studied a disease occurring on *Platanus racemosa* Nutt., in California, whose causal fungus he identified as *Stigmina Platani.* In the same year an organism that is undoubtedly identical was described as *Stigmella Platani-racemosae* Dearn. & Barth. (**3**). It was collected on the same species of sycamore at Riverside, California, July 9, 1924, by Bartholomew. Through the kindness of C. O. Smith specimens of this sycamore fungus, collected December 1935, were sent me for comparison with *Stigmina Platani.* As Dearness indicated (**3**) these two organisms are closely related. They are sufficiently distinct, however, to be regarded as separate species, and so long as the two form genera *Stigmina* and *Stigmella* are retained, they should be regarded as generically distinct.

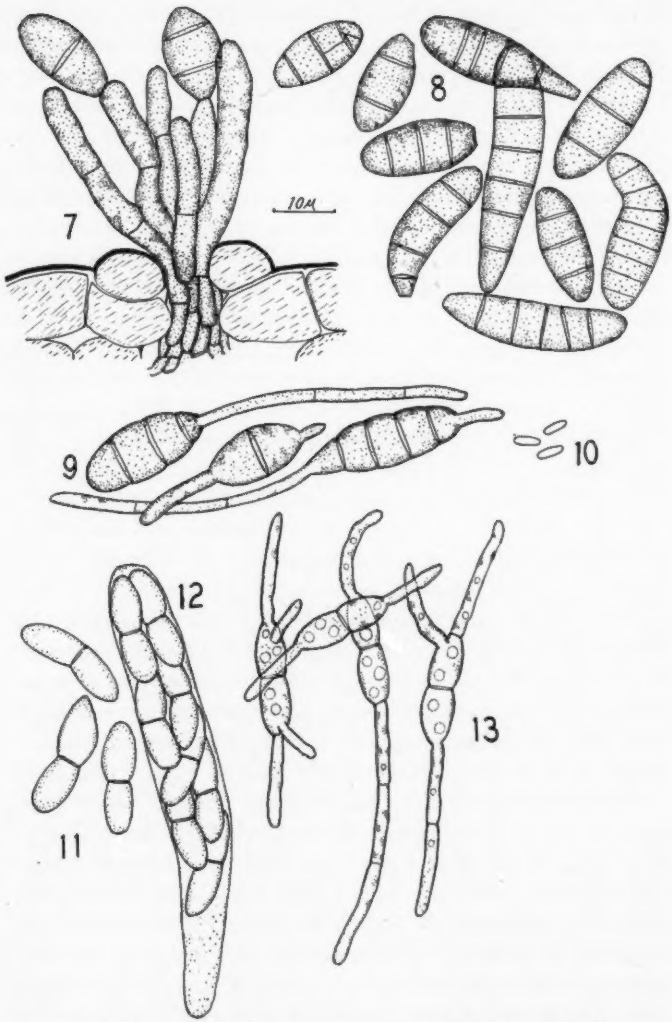

FIG. 7, fascicle of conidiophores of *Stigmina platani* protruding from stomatal aperture; 8, variation in shape and septation of conidia of *S. Platani;* 9, germination of conidia; 10, spermatia; 11, ascospores of *Mycosphaerella Stigmina-Platani;* 12, ascus of *M. Stigmina-Platani;* 13, germinating ascospores.

Spermogonia and Perithecia.—Spermogonial and perithecial primordia begin to form concurrently, prior to abscission of affected foliage. They are interspersed on the lower leaf surface. Under low magnification the lesions are seen to be densely occupied by dark, punctiform structures that protrude slightly. The two structures can be distinguished microscopically only after the spermogonia have matured on fallen leaves. The spermatia are liberated for a period of about two months beginning near the middle of September. It appears probable that both pathogens possess spermogonial stages. It has been impossible to establish this because of the intimate intermingling of the two fungi and the fact that all of the spermogonia are similar as are also the spermatia. The spermogonia are globoid, 50–70 μ in diameter, and emit a profusion of rod-shaped spermatia $2–3 \times 1\ \mu$ (FIG. 10). Spermogonia were developed in cultures grown on agar enriched by a decoction of sycamore leaves and inoculated with pure cultures isolated from the conidial stage of *Stigmina*. By April or May the perithecial stromata will have become transformed into mature perithecia, if infected leaves are over-wintered out-of-doors. In vertical section, the perithecia are seen to be globular structures with a perforation extending through the papillate apex. Their wall is dark, thin, and membranous. The asci are saccate and contain biseriately arranged, 2-celled, hyaline ascospores. Paraphyses are wanting. Preparations obtained by maceration show that the asci adhere in a fascicle. These characteristics are clearly those of the genus *Mycosphaerella*.

Although the perithecia from decaying sycamore leaves are all quite similar in size, the asci and ascospores are found to belong to two groups. The asci from certain of the perithecia measure $55–70 \times 9–11\ \mu$ (FIG. 12), and contain ascospores $17–19 \times 6–7\ \mu$ (FIG. 11), those from the remainder, $30–36 \times 7–8\ \mu$ (FIG. 5), and $8–10 \times 4–4.5\ \mu$ (FIG. 4), respectively. The perithecia are intermingled. The differences in size were at first attributed to differences in state of maturity. It became evident, however, as the investigation progressed, and as will be shown subsequently, that two distinct species of *Mycosphaerella* are associated together on the decaying leaves.

Genetic Relationship of Conidial and Perithecial Stages.—

Genetic connection of conidial and perithecial stages rests mainly upon evidence obtained from the use of pure cultures.

Watery suspensions of conidia in dilution poured agar plate cultures were employed in separating and isolating *Cercospora platanifolia* from *Stigmina Platani*. From such plates, 48-hour-old colonies were transferred to slanted tubes of potato agar and of malt agar, and the colonies resulting from such isolates were found to belong to two groups. Similarly ascospores were permitted to be ejected onto agar in Petri dishes inverted above moist leaves bearing mature perithecia. Blocks of agar with adhering single ascospores were removed to slanted tubes of agar. The isolates obtained in this manner were found to belong either to one or the other of two different kinds, those colonies developing from large ascospores being of one kind and from small ascospores being of the other. Moreover the cultures isolated from the large-spored *Mycosphaerella* were like those isolated from conidia of *Stigmina Platani* and those from the small-spored *Mycosphaerella* were like those of *Cercospora platanifolia.*

Conidial production was not noted in any of the pure cultures, and for this reason artificial inoculations with pure cultures were not attempted. Instead, the inoculum consisted of leaves bearing perithecia. These leaves were fastened to trees that, in the previous year, had remained free from infection. Lesions were found to develop on the foliage of trees inoculated in this manner at the same time that they appeared on the lowermost leaves of trees beneath which there were decaying, infected leaves. Both *Cercospora platanifolia* and *Stigmina Platani* developed on the leaves, to which crude perithecial inoculum was applied. The *Cercospora* appeared first and about four weeks later *Stigmina* also developed. These experiments show that old leaves bearing perithecia are sources of inoculum. It is of interest to note in this connection that young trees, which had been defoliated during the preceding season by these pathogens, remained free from infection when they were transplanted, during winter, to situations remote from diseased sycamores.

Taxonomy.—A survey of the literature dealing with fungi on *Platanus* reveals that four species of *Mycosphaerella* (*Sphaerella*) have been recorded to occur on this host; namely *Sphaerella*

Platani Ellis & Mart., *S. circumdans* Pass., *S. maculiformis* Auserw., and *S. platanifolia* Cooke. The first two of these are clearly different from the organisms under consideration in this report, since they occur on leaf lesions on green but languid leaves and their perithecia are epiphyllous. *S. maculiformis* occurs on decaying leaves of several additional species of deciduous hardwoods, and although its perithecia are hypophyllous, its asci and ascospores differ in size from both organisms under consideration.

The small-spored *Mycosphaerella* agrees well with the type of *Sphaerella platanifolia* Cooke (**2**) with which it has been compared and with which it is believed to be identical. This organism was collected on leaves of *Platanus occidentalis* in Georgia, in 1883, by Ravenel, and it is probably widely prevalent in the southeastern United States. Its conidial stage (**4**) was first collected in Louisiana twelve years earlier.

The large-spored *Mycosphaerella* associated with the long-known parasitic stage, *Stigmina Platani,* is believed to be undescribed. In order to associate it with its conidial stage therefore, the specific name *Stigmina-Platani* is proposed and the fungus is briefly characterized as follows:

Mycosphaerella Stigmina-Platani sp. nov.

Perithecia in vernale in putrescentibus foliis efformantia, hypophylla per totum folium dense dispersa, punctiformia, nigra, erumpenti-immersa, sphaeroidea 65–85 μ diam., ascis sacciformibus, fasciculatis, octosporis, aparaphysatis, 55–70 × 9–11 μ; sporidiis biseriatis, loculis inaequalibus, loculo superiore crassiore, hyalinis, rectis vel curvulis, 17–19 × 6–7 μ.

Spermogoniis autumno efformantibus, numerosis, hypophyllis, innato-prominulis, paginis inferioribus ex toto vel in maculis exaridis occupantibus, ovatis vel globosis, nigris, 55–65 μ; spermatiis bacillaribus, 2–3 × 1 μ, hyalinis. Hab. in foliis dejectis Platani.

Status conidicus: Statum conidicum *Stigmina Platani* (Fckl.) Sacc. sistit. Caespitulis hypophyllis, atris, primo maculicolis deinde subeffusis; conidiis ovatis, ovato-oblongis, v. late clavatis, 15–40 × 8–10 μ intense olivaceis, 1–8-septatis (plerumque 3-septatis), non constrictis; conidiophoris fasciculatis, fuscidulis, conidio paulo longioribus. Hab. in pagina inferiore *Platani* spp.

Syn. *Puccinia* sp. Unger Exanth., p. 181.
Puccinia Platani Bivona Stirp. rar. Sic., p. 16, tab. 3, fig. 5.
Stigmella Platani Fuckel, Bot. Zeit. **29**: 27, 1871; Hedwigia **11**: 181.
Sicc. Thüm. Myc. Univ. No. *889*. Rab. Fungi Europaei no. *1551;* Roumg. Fungi Gall. no. *191.*

Stigmina Platani (Fuckel) Sacc. Fungi Ital. *931;* Sacc. Syll. **4**: 394; Lindau in Rab. Krypt.-Fl. (2d edit.) **9**: 20.

Oudemans (**5**) used Thümen rather than Fuckel in the combination *Stigmina Platani*. This is in error. It appears from Thümen's (**8**) account that the specimens of this fungus sent him from

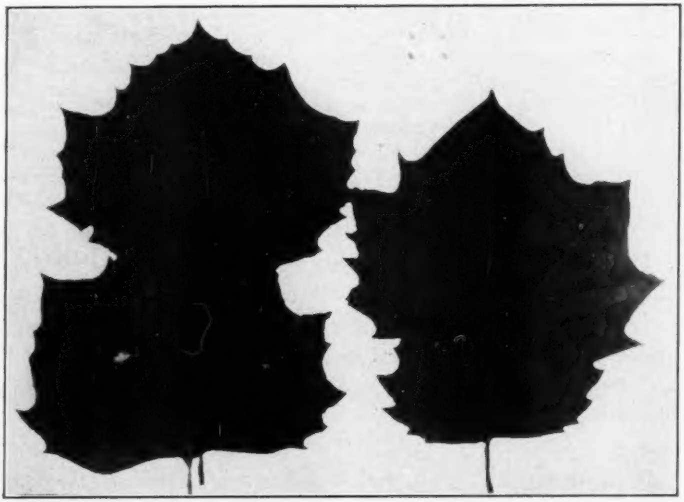

FIG. 14. Diseased sycamore leaves. At the upper left a leaf with lesions induced by *Cercospora platanifolia;* below it one with necrotic lesions on which both *Cercospora platanifolia* and *Stigmina Platani* occur. The two leaves at the right have spots covered with an effuse black coating consisting of fructifications of *Stigmina Platani.*

Greece were forwarded to Herr Leopold Fuckel for determination. Fuckel named the organism and Thümen (**8**) briefly described it using the name *Stigmella Platani* Fuckel in his account. Saccardo (**6** & **7**) referred it to *Stigmina Platani* (Fuckel) in his reports in 1878 and 1880.

As a result of the present studies *Cercospora platanifolia* and *Sphaerella platanifolia* are shown to be stages of the same fungus. A complete description is therefore assembled as follows:

Mycosphaerella platanifolia Cooke.

Syn. *Sphaerella platanifolia* Cooke, Jour. Bot. **21**: 106, 1883. Sacc. Syll. **2**: append., p. XXXVI; Sacc. Syll. **9**: 645; Hedwigia **22**: 139.

Sicc. Rav. N. Am. Fungi No. *756*.

Hypophylla, sparsa; perithecis exiguis, atris, semi-immersis, punctiformibus circa 70 μ in diam.; ascis clavatis, sessilibus, 30–36 $\times$ 7–8 μ; sporidiis biseriatis, subellipticis, uniseptatis, hyalinis, loculo inferiore tenuiore, 8–10 $\times$ 4–4.5 μ. Hab. in vernale in foliis putridis, *Platani occidentalis*.

Spermogoniis autumno efformantibus, dense gregariis, hypophyllis, globosis, 55–65 μ; spermatiis hyalinis, bacilliformibus, 2–3 $\times$ 1 μ.

Status conidicus: Statum conidicum *Cercospora platanifolia* Ellis & Ev. sistit. Maculis amphigenis, minutis, 1–3 mm. diam., sparsis, irregularibus, indefinitis, sordide atro-brunneis; hyphis amphigenis, e basi tuberculari sphaeriformi atra minute fasciculatis, brevibus, subferrugineis, parce denticulatis; conidiis angustate obclavatis, plerumque curvis, nucleatis, 30–60 $\times$ 3.5–4 μ. Hab. in folia viva *Platani occidentalis*.

Specimens of both organisms have been deposited in the Farlow Herbarium, Harvard University; the herbarium of the New York Botanical Garden, and that of the Mycology and Disease Survey of the U. S. Dept. of Agriculture. I am greatly appreciative of the help given me by Dr. D. H. Linder, The Farlow Library and Herbarium, Harvard University.

SUMMARY

Two conidial fungi, *Cercospora platanifolia* and *Stigmina Platani,* occur together on the foliage of sycamore. They cause a leaf blight disease that occasions severe defoliation.

During autumn spermogonia and perithecial primordia are initiated concurrently on the fallen leaves.

After about two months spermatia cease to be formed and by the following spring the perithecial stages are mature. The perfect stage of *Cercospora platanifolia* is *Mycosphaerella platanifolia* Cooke; that of *Stigmina Platani* has not previously been described and is herein given the name *Mycosphaerella Stigmina-Platani.*

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CULTURAL STUDIES IN THE THELEPHORACEAE AND RELATED FUNGI [1]

ROSEMARY BIGGS [2]

(WITH 20 FIGURES)

During the years 1935, 1936 and 1937 a number of species of Thelephoraceae and related fungi were obtained in monosporous culture. Among these, twenty-five proved to be heterothallic and in twelve species the type of heterothallism was determined. Although few of these species appeared sufficiently unusual or important to warrant any especial investigation, it was thought that the results of the general observations might be of value to any mycologist contemplating cultural studies in this group. The complete results are therefore presented in tables I–III.

As a general observation on these tables it will be seen that asexual reproduction is of rare occurrence in the artificial cultures of these fungi. Previous cultural studies have led to the conclusions: (1) that oidia are of extremely common occurrence in the Hymenomycetes; (2) that conidia are more commonly produced by species of the Thelephoraceae than those of other groups. The results of this study are not in accordance with these views and it might therefore be of value to discuss this problem in somewhat greater detail.

In the higher Hymenomycetes, oidia occur so generally that Brodie (**1936**) felt justified in making the statement that: "Oidia occur so commonly in the Hymenomycetes that a monocaryon mycelium which fails to produce them is a rarity."

In the eighteen species of thelephoraceous fungi with which Miss Nobles (**1935**) worked no oidia were ever observed. In the total of fifty species observed in monosporous culture by the writer, oidia occurred in three species, viz. *Corticium coronilla* v. Höhn.

[1] Contribution from the Department of Botany, University of Toronto.

[2] This study has been carried out under the direction of Professor H. S. Jackson, to whom I wish to express my appreciation for his continued interest and helpful suggestions.

TABLE I

SPECIES OF THELEPHORACEAE AND RELATED FUNGI IN WHICH THE TYPE OF HETEROTHALLISM WAS DETERMINED

Species	Culture Number	Herbarium Number	Number of Monosporous Cultures	Asexual Reproduction in Culture	Basidiospore Fructification in Culture	Type of Heterothallism
Corticium coronilla‡ group I	585	10260	14	None	None	Bipolar
Corticium coronilla‡ group II	617	10267	20	None	In both mono- and polysporous cultures	Homothallic
Corticium coronilla‡ group III	566	10246	26	Oidia and bulbils	None	Tetrapolar
Corticium coronilla‡ group IV	647	10248	5	None	None	?
Cytidia salicina (Fries) Burt	268* 833		17 30	None	None	Tetrapolar
Odontia setigera (Fries) Miller	302 323 398 355	8572 8571 8573 8570	32 33 25 23	None	None In polysporous culture	Bipolar
Odontia sudans Burt	256*	5471	30	None	None	Tetrapolar
Peniophora affinis Burt	232*	6497	30	None	None	Bipolar
Peniophora candida (Pers.) Lyman	713	9918	37	Bulbils	In very old cultures	Tetrapolar†
Peniophora cinerea (Pers.) Cooke	270*	6518	30	None	None	Tetrapolar
Peniophora farinosa Bres.	20		24	None	None	Tetrapolar†
Peniophora incarnata (Pers.) Karst.	287*	6551	30	None	None	Tetrapolar
Peniophora pubera (Fries) Sacc.	258*	6491	25	None	None	Bipolar
Peniophora ludoviciana Burt	492 767	8845 9920	48 29	None	In both mono- and polysporous cultures	Bipolar
Phlebia strigozonata (Schw.) Burt	336	8600	33	Oidia	None	Bipolar
Radulum orbiculare Fries	822		30	None	None	Tetrapolar†
Stereum rufum Fries	806		20	None	None	Tetrapolar†

* Monosporous cultures isolated by Miss M. K. Nobles.
† Table of heterothallism worked out by Mr. R. C. Lacy (**1937**).
‡ See Biggs (1937).

TABLE II

SPECIES IN WHICH CLAMP CONNECTIONS WERE PRODUCED IN POLYSPOROUS CULTURES BUT LACKING FROM THE MONOSPOROUS CULTURES, INDICATING HETEROTHALLISM

Species	Culture Number	Herbarium Number	Number of Monosporous Cultures	Asexual Reproduction in Culture	Basidiospore Fructification in Culture
Corticium calceum Burt	468	6217	25	Conidia	None
Corticium hydnans (Schw.) Burt	322	8222	30	None	None
Corticium laeve Pers.	368 460	8869 8693	27 30	None	None
Corticium polygonium Pers.	369	8711	26	None	None
Corticium porosum (B. & G.) Wakef.	309	8225	23	None	None
Corticium stramineum Bres.	341	8708	13	None	None
Corticium radiosum Fries	487	8228	30	None	None
Odontia fuscoatra (Fries) Bres.	409	8554	25	None	None
Peniophora laevis (Fries) Burt	449	8753	35	None	None
Peniophora versata Burt ?	463	8267	23	None	None
Peniophora violaceo livida (Sommf.) Bres.	430	8266	31	None	None
Stereum Murrayi (Berk. & Curt.) Burt	313 354	8276 8908	13 6	None	None

TABLE III

SPECIES IN WHICH TRUE CLAMP CONNECTIONS WERE LACKING FROM BOTH POLYSPOROUS AND MONOSPOROUS CULTURES

Species	Culture Number	Herbarium Number	Number of Monosporous Cultures	Asexual Reproduction in Culture	Basidiospore Fructification in Culture	Nuclear Content of Cells
Ceratobasidium cornygerum (B. & G.) Rogers	318	8476	30	None	None	?
	424	8849	33	None	None	?
Coniophora cerebella Pers.			Tissue cultures	None	None	Multinucleate
Corticium sp.	526	10180	20	None	None	Multinucleate
Hymenochaete tabacina	456	8246	32	None	None	?
Peniophora sp.	439	8250	25	None	None	?
Peniophora sp.	458	8259	31	None	In both mono- and polysporous cultures	Multinucleate
Peniophora gigantea (Fries) Massee	392	8756	27	Oidia borne in chains in both mono- and polysporous cultures	None	Multinucleate
	690	9928	11			
	796	9924	25			
Peniophora sordida (Karst.) Burt	307	8264	36	None	None	Multinucleate
	320	8248	36			
Stereum fuscum Schrad.	387	8269	34*	None	In both mono- and polysporous cultures	?

& Litsch., *Phlebia strigozonata* (Schw.) Burt, and *Peniophora gigantea* (Fries) Massee. The only published description of oidia in the Thelephoraceae which has come to our attention is that of Butler (**1930**) for *Corticium centrifugum* Lév.

It is therefore evident that oidia are of far rarer occurrence in the Thelephoraceae than in the higher groups of the Hymenomycetes.

With regard to the production of conidia, this spore form is of infrequent occurrence in the higher Hymenomycetes. True conidia have been described in *Pleurotus pinsitus* Fries by Vandendries (**1934**), in *Pleurotus corticatus* Fries by Kaufert (**1935**) and in *Fomes annosus* Bres. by Brefeld (**1889**).

On the other hand, in the few cultural studies that have been made with members of the Thelephoraceae, a number of conidial forms have been observed. Brefeld (**1889**) described the production of conidia on somewhat swollen hyphal ends in species of *Hypochnus*. Conidia borne on oedocephaloid heads have been de-

scribed for *Corticium effuscatum* Cooke & Ellis (Lyman **1907**, Nobles **1935**), *Peniophora Allescheri* Bres. (Nobles **1935**, **1935a**), *Peniophora mutata* Peck and *Peniophora heterocystidia* Burt (Nobles in litt.). In *Corticium incrustans* v. Höhn. & Litsch. (*Corticium roseopallens* Burt) conidia are borne directly on the vegetative hyphae (Lyman **1907**, Nobles **1935**, **1937**).

These studies would seem to indicate that conidia may be of rather common occurrence in the Thelephoraceae. However, in the fungi studied by the writer conidia were found in the single species *Corticium calceum* Burt. From this it would appear that in the previous investigations of this group the conidial species had accidentally been selected and that conidia probably occur no more commonly in the Thelephoraceae than in any other group of the Hymenomycetes.

Among the species listed in tables I–III are several fungi whose life cycles are of especial significance. These fungi will now be considered in greater detail.

Cytidia salicina (Fries) Burt

In this species the heterothallism is of the tetrapolar type and the table of pairing reactions for no. 833 is given in table IV. In this organism two secondary reactions are controlled by one of the copulation factors. These reactions, barrage reaction and the production of false clamp connections, have been described separately; the barrage reaction by Vandendries and Brodie (**1933**), working with various species of Agaricaceae and Polyporaceae, and the false clamp connection reaction by Quintanilha (**1935**) for *Coprinus fimetarius* Fries.

To consider first the barrage reaction. In various tetrapolar species of Hymenomycetes, Vandendries and Brodie have observed that a distinct aversion reaction occurs on the pairing of certain monosporous mycelia. This reaction does not occur in an haphazard manner but results only on the confrontation of two mycelia which possess one of the reaction factors, arbitrarily chosen, in common. For instance, aversion occurs on pairing mycelia of constitution Ab and ab or AB and aB. In these combinations the "B" factor is common to both the reacting mycelia. This aversion reaction has been called a barrage reaction.

TABLE IV

TABLE OF PAIRING TWENTY-FOUR MONOSPOROUS MYCELIA OF *Cytidia salicina* (FRIES) BURT, SHOWING THE PRODUCTION OF FALSE CLAMP CONNECTIONS ( ) AND BARRAGE REACTION (.) ON THE COMMUNITY OF THE "B" FACTOR

		AB										ab				Ab					aB					
		2	3	4	7	9	10	12	22	23	24	1	13	17	21	5	14	19	20	25	6	8	11	15	16	18
AB	2	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥	⊥·	⊥·	⊥·	+	⊥·
	3	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥·	⊥·	⊥·	⊥·	⊥·	⊥·
	4	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥	⊥	⊥·	⊥·	⊥·	⊥·
	7	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥·	⊥·	⊥·	⊥·	⊥·	⊥·
	9	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥·	⊥·	⊥·	⊥·	−	⊥·
	10	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥·	⊥·	−	⊥·	⊥·	⊥·
	12	−	−	−	−	−	⊥	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥·	⊥·	⊥·	⊥·	⊥·	−
	22	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥	−·	⊥·	⊥·	⊥·	⊥·
	23	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	−	−	−	−	−·	−
	24	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	⊥·	⊥·	⊥·	⊥·	⊥·	⊥·
ab	1	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−·	⊥·	⊥·	−·	⊥·	−	−	−	−	−	−
	13	+	+	+	+	+	+	+	+	+	+	−	−	−	−	⊥·	−	⊥·	⊥·	⊥·	−	−	−	−	−	−
	17	+	+	+	+	+	+	+	+	+	+	−	−	−	−	⊥·	⊥·	⊥	⊥·	⊥·	−	−	−	−	−	−
	21	+	+	+	+	+	+	+	+	+	+	−	−	−	−	⊥·	⊥·	⊥·	⊥	⊥·	−	−	−	−	−	−
Ab	5	−	−	−	−	−	−	−	−	−	−·	−·	⊥·	⊥·	⊥·	−	−	−	−	−	+	+	+	+	+	+
	14	−	−	−	−	−	−	−	−	−	−	⊥·	−	⊥·	⊥·	−	−	−	−	−	+	+	+	+	+	+
	19	−	−	−	−	−	−	−	−	−	−	⊥·	⊥·	⊥	⊥·	−	−	−	−	−	+	+	+	+	+	+
	20	−	−	−	−	−	−	−	−	−	−	−·	⊥·	⊥·	⊥	−	−	−	−	−	+	+	+	+	+	+
	25	−	−	−	−	−	−	−	−	−	−	⊥·	⊥·	⊥·	⊥·	−	−	−	−	−	+	+	+	+	+	+
aB	6	⊥	⊥·	⊥·	⊥·	⊥·	⊥·	⊥·	⊥	−	⊥·	−	−	−	−	+	+	+	+	+	−	−	−	−	−	−
	8	⊥·	⊥·	⊥	⊥·	⊥·	⊥·	⊥·	−·	−	⊥·	−	−	−	−	+	+	+	+	+	−	−	−	−	−	−
	11	⊥·	⊥·	⊥·	⊥·	⊥·	−	⊥·	⊥·	−	⊥·	−	−	−	−	+	+	+	+	+	−	−	−	−	−	−
	15	⊥·	⊥·	⊥·	⊥·	⊥·	⊥·	⊥·	⊥·	−	⊥·	−	−	−	−	+	+	+	+	+	−	−	−	−	−	−
	16	⊥·	⊥·	⊥·	⊥·	−	⊥·	⊥·	⊥·	−·	⊥·	−	−	−	−	+	+	+	+	+	−	−	−	−	−	−
	18	⊥·	⊥·	⊥·	⊥·	⊥·	⊥·	−	⊥·	−	⊥·	−	−	−	−	+	+	+	+	+	−	−	−	−	−	−

Like the barrage reaction, the false clamp connection reaction also occurs on the pairing of two monosporous mycelia which possess one of the copulation factors in common. This reaction has been observed by various authors, including Vandendries (**1933** etc.) and Oort (**1930**), and has been studied in detail by Quintanilha (**1935**). In this reaction the hyphae of the two mycelia fuse, the nuclei assume a dicaryon association in the terminal cells and conjugate nuclear division occurs. In each terminal cell a clamp connection begins to form and one of the daughter nuclei passes into the immature hook. This hook is, however, never completed and consequently one of the daughter nuclei fails to

reach the penultimate cell. The hybrid mycelium is therefore a composite growth; the terminal cells contain dicaryon nuclei and the older cells are uninucleate.

In *Cytidia salicina* (Fries) Burt, both of these reactions occur and both are associated with the community of the same reaction factor; this is clearly indicated by the localisation of the reactions in table IV.

PENIOPHORA LUDOVICIANA Burt

In this species the heterothallism is of the bipolar type. The cells of the haploid mycelium are consistently multinucleate. The actively growing cells are always extremely long and contain large numbers of nuclei. In old partially emptied cells the number of nuclei is much reduced but consistently uninucleate cells were not observed.

The diploid mycelium initiates its growth with multinucleate cells but ultimately produces normal binucleate hyphae. The extent of the multinucleate growth depends largely on the conditions. If a transfer is made from a young actively growing diploid culture, the multinucleate hyphae will cover the entire plate before binucleate cells begin to appear towards the centre of the colony. If, on the other hand, a transfer is made from the fruiting surface of an old stale culture, clamp connections are produced almost immediately.

A cytological study of the diploid mycelium showed that the clamp bearing cells are binucleate and that conjugate division occurs in the usual manner. In the transition from the multinucleate to the binucleate structure a number of abnormalities were observed. In some cells the hook of the clamp connection failed to fuse with the penultimate cell as in the false clamp connections of Quintanilha (**1935**). In these hyphae the terminal cell usually contained a relatively large number of nuclei. In other cells, containing more than two nuclei, simultaneous nuclear division occurs in association with clamp formation (FIG. 1–7).

Peniophora ludoviciana Burt fruits readily in both the monosporous and polysporous cultures. The hymenium of the diploid fructification usually appears a week or more earlier and is usually thicker than that of the haploid. The basidia of both the haploid and the diploid fructifications are four-spored.

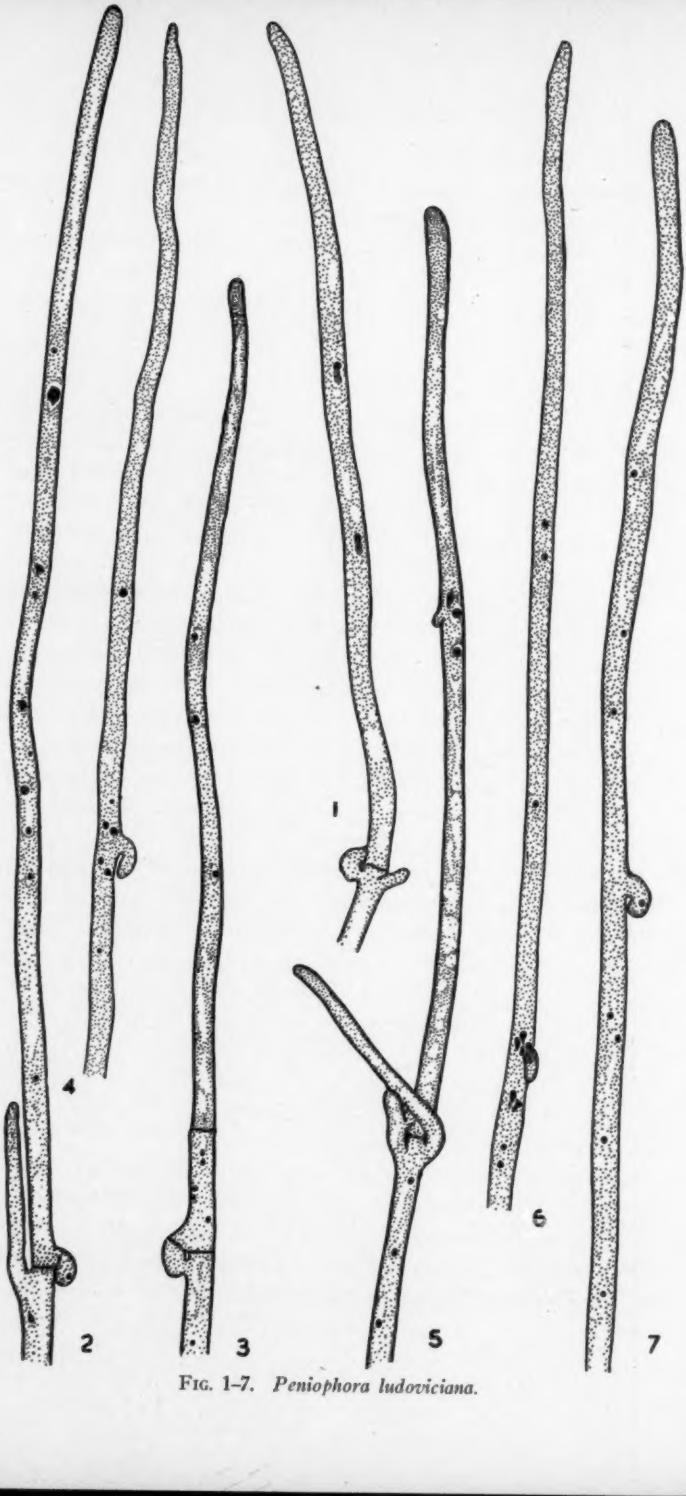
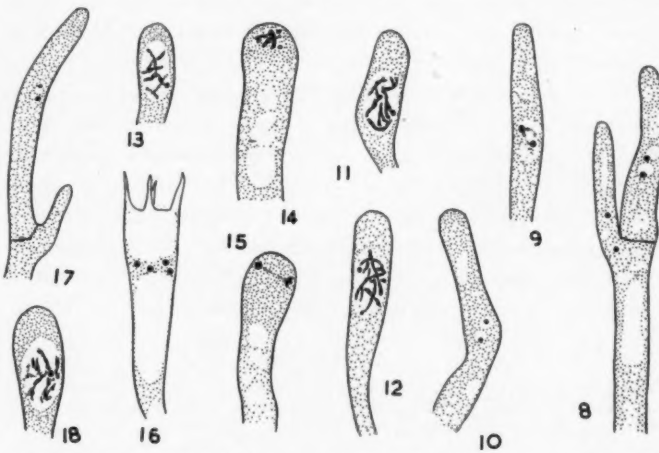


Fig. 1–7. *Peniophora ludoviciana.*

When the cytology of the haploid hymenium was studied it was found that the young basidia were regularly binucleate and that in later stages the basidia contained a large fusion nucleus. The stages in basidial development were not studied in great detail, the basidia are extremely small and the process of development of the basidium has been described by other workers (Kniep **1916**, etc.,



FIGS. 8–18. Basidial development in *Peniophora ludoviciana* Burt; 8–16, haploid basidia; 17–18, diploid basidia; 8, passage of two subhymenial nuclei into a young haploid basidium; 9, 10, binucleate haploid basidia; 11, 12, 13, haploid basidia showing fusion nuclei; 14, 15, division stages of the fusion nuclei of haploid basidia; 16, old haploid basidium with four residual nuclei; 17, binucleate diploid basidium; 18, diploid basidium with a fusion nucleus. Magn. × 1800.

Smith **1934**, Wakayama **1930**, etc.). It was considered of little value to reduplicate these results with far less favourable material. The occurrence of a fusion nucleus in the haploid basidium is, however, of some theoretical interest; the general outline of the development was therefore followed.

The young basidium is binucleate (FIG. 8). The two nuclei as-

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FIGS. 1–7. The development of clamp connections in *Peniophora ludoviciana* Burt during the transition from the multinucleate to the binucleate cell structure; 1, normal diploid binucleate cell; 2, multinucleate cell with a false clamp connection at the base; 3, multinucleate clamp bearing cell divided by a plain septum into two cells; 4–7, cells showing the association of more than two nuclei with clamp formation. Magn. × 900.

sociate and fuse, the fusion nucleus enlarges (FIG. 10–13) and passes to the apex of the basidium where it divides. Various division stages described as characteristic of meiosis in the Hymenomycetes were observed (FIG. 14, 15). The basidium finally becomes eight-nucleate, one nucleus passes into each spore and four nuclei degenerate in the old basidium. The exact number of nuclei in the subhymenial cells could not readily be determined but it was clear that this number was variable and that there was no association of nuclei in pairs.

The development of the diploid basidium was found to be similar, except that the young basidia always possessed a clamp connection at the base and that the subhymenial cells were consistently binucleate (FIG. 17–18).

Single spore cultures were isolated from the haploid and diploid strains which had been examined cytologically. As was to be expected the monosporous mycelia from the haploid fructification were all of the same potentiality as the parent (table V). On the

TABLE V

Peniophora ludoviciana BURT, PAIRING REACTIONS OF TWENTY MONOSPOROUS MYCELIA FROM AN HAPLOID FRUCTIFICATION WITH TWO REPRESENTATIVE A AND a HAPLOID MYCELIA

	a																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A 5	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
a 4	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−

other hand, the monosporous mycelia from the diploid fructification could be divided into the two parental strains in approximately equal numbers (table VI).

TABLE VI

Peniophora ludoviciana BURT, PAIRING REACTIONS OF TWENTY MONOSPOROUS MYCELIA FROM A DIPLOID FRUCTIFICATION WITH TWO REPRESENTATIVE A AND a HAPLOID MYCELIA

	A							a												
	4	8	10	11	12	15	18	1	2	3	5	6	7	9	13	14	16	17	19	20
A 4	−	−	−	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+
a 5	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−

The life cycle of *Peniophora ludoviciana* Burt is represented in the diagram of figure 19. In this life cycle two distinct types of

fusion nuclei occur: (1) Those formed by the fusion of two haploid nuclei of the same potentiality, (2) Those formed by the fusion of two haploid nuclei of opposite potentiality. This life cycle provides additional evidence as to the possible method of origin of homothallic species. It might therefore be of value to outline this problem in the Basidiomycetes.

In an heterothallic organism a self sterility mechanism assures that the gametic fusing nuclei are genetically differentiated. The fusion of genetically different nuclei followed by the segregation of chromosomes at reduction division assures within the species a wide distribution of mutant characters together with a maximum number of recombinations of existent heterozygous characters. These heterothallic species are well equipped to respond to new and changing environmental conditions and will therefore include the progressive elements in any group.

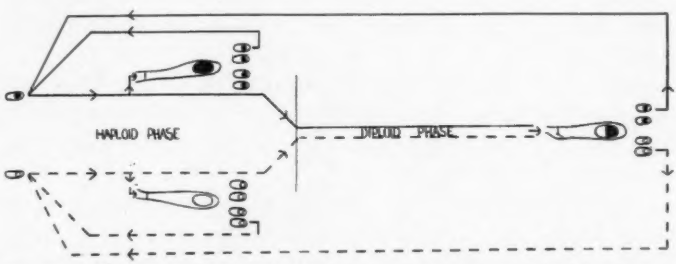

FIG. 19. Diagram illustrating the life cycle of *Peniophora ludoviciana* Burt.

On the other hand, in the homothallic species which complete the whole life cycle from a single nucleus, the process of nuclear fusion and reduction division can have no genetical significance. It would seem improbable that these homothallic species can play any progressive role in the evolution of any but the simplest and most primitive groups.

If these concepts of heterothallic and homothallic species are accepted, then one would expect that modern homothallic species should represent simplified derivatives from ancestral heterothallic species. These derivatives could be conceived of as arising as a result of the more or less complete supression of the self sterility mechanism. If this hypothesis is tenable, one would expect to

find closely related homothallic and heterothallic species in the modern flora. These homothallic species should include a wide range of variation in the nuclear life cycle depending on the degree of suppression of the self-sterility mechanism. For instance in the Basidiomycetes one should expect to find homothallic fungi with the following types of life cycles: (1) The haploid phase is entirely suppressed the dicaryon association originates in the spore; (2) The entire life cycle is retained including haploid and diploid phases and nuclear fusion; (3) The haploid phase predominates, no dicaryon association occurs and the first binucleate cells arise in the hymenium where nuclear fusion occurs; (4) A dicaryon phase develops but nuclear fusion fails to occur; (5) The life cycle is wholly haploid lacking both dicaryon and nuclear fusion. These five categories suggest the main types of organization that should be found in homothallic species. It is evident that many variations on these general themes are possible and that many distinct types of organization may be added in the light of future knowledge.

A detailed analysis of the interrelationships within the Uredineae has provided a valuable body of cumulative evidence suggesting that the short cycled homothallic species have arisen from long cycled heterothallic species (H. S. Jackson **1931**, **1936**). Moreover, the homothallic species of the Uredineae present exactly the range of variation in nuclear organization that would be expected on the above hypothesis. In this group, then, the evidence would suggest that homothallic species have been derived from heterothallic ancestors.

By analogy it would seem reasonable to suppose that the homothallic species of the Hymenomycetes have arisen in a similar manner from heterothallic ancestors. In support of this view there is clear evidence that many of the entirely haploid homothallic species have arisen as independent haploid strains of heterothallic ancestors (Bauch **1925**, **1927**, Smith **1934**, etc.). In this connection *Peniophora ludoviciana* Burt is of some importance. An independent haploid strain of this species would give rise to an homothallic species corresponding to type 3 of the above scheme. Homothallic species of this organization have been reported but in no case has a relationship to any extant heterothallic species been

suggested. Further, although few species have been studied, the homothallic species do show a considerable range of nuclear organization and in all probability a further study would disclose other types of nuclear organization in the homothallic species of the Hymenomycetes.

SPECIES WITH MULTINUCLEATE CELLS

In table III a number of species entirely devoid of true clamp connections have been listed. Five species were found to possess multinucleate cells. Of these *Peniophora gigantea* (Fries) Massee, *Coniophora cerebella* Pers. and an unidentified species of *Corticium, no. 526,* possibly related to *Corticium laeve* Pers. were unusual in their organization. These fungi produced abnormal

FIG. 20. Photograph of a portion of a multinucleate hypha of *Peniophora gigantea* (Fries) Massee showing three nuclei in a mature clamp and five nuclei in a young side branch in process of forming a clamp connection. Magn. × 1000.

clamp connections directly on the multinucleate cells. These abnormal clamp bearing fungi differ from normal diploid clamp bearing organisms in the following respects:

(1) Two or more clamps may be produced at one cross septum; in *Coniophora cerebella* Pers. as many as five or six clamps are commonly formed.

(2) The fusion of the hook cell with the penultimate cell is retarded or may fail to occur.

(3) The clamp hyphae may contain three or four nuclei (FIG. 20).

(4) The nuclei in any one multinucleate cell do not divide simultaneously but divide at random in various parts of the cell.

(5) The clamp connections are formed rather in association with cell division than nuclear division.

The development of these abnormal clamp connections has recently been described by Greis (**1937**) for *Coniophora cerebella* Pers. The observations of the writer confirm those of Greis and therefore need not be repeated here.

In *Peniophora gigantea* (Fries) Massee and *Corticium* sp. *no. 526* the abnormal clamp connections were present in both the monosporous and the polysporous cultures. If these structures are of any significance then these species must be considered as homothallic. Monosporous cultures of *Coniophora cerebella* Pers. were not obtained and it is therefore uncertain whether this species should be considered as homothallic or heterothallic.

The three species varied in the prevalence of abnormal clamp connections in artificial culture. In *Coniophora cerebella* Pers. they were present at the cross walls of the majority of the actively growing aerial hyphae. In *Corticium* sp. *no. 526* they were observed in the aerial mycelium which accumulates at the top of the slant. In *Peniophora gigantea* (Fries) Massee they were absent from the normal cultures but appeared quite frequently when the mycelium was grown on thin films of agar for cytological investigation.

An examination of the original specimens of these three species showed that abnormal clamp connections are more or less frequent in occurrence on the actively growing periferal hyphae, but that basidia and tramal cells lacked any clamp connections. A careful examination of the periferal hyphae in the herbarium specimens of other members of the Thelephoraceae showed that similar abnormal clamp connections are produced by *Peniophora carnosa* Burt, *Peniophora sanguinea* Fries and *Peniophora velutina* DC.

SUMMARY

1. The results of a general cultural investigation with species of the Thelephoraceae and related fungi are presented in tables I–III.

2. In *Cytidia salicina* (Fries) Burt the heterothallism is of the tetrapolar type, both the barrage reaction, described by Vandendries and Brodie (**1933**), and the false clamp connection reaction, described by Quintanilha (**1935**), occur on the community of the " B " factor.

3. In *Peniophora ludoviciana* Burt the heterothallism is of the bipolar type. The cells of the haploid hyphae are always multinucleate. The cells of the diploid hyphae are initially multinucleate but finally binucleate clamp bearing cells develop. In this species both the haploid and the diploid mycelia produce basidiospore fructifications in culture. The young haploid basidia are binucleate and a fusion of nuclei occurs. The occurrence of a fusion nucleus in the haploid phase provides additional evidence of the origin of homothallic species from heterothallic ancestors.

4. In *Peniophora gigantea* (Fries) Massee, *Coniophora cerebella* Pers. and an unidentified species of *Corticium, no. 526,* the cells of the mycelium of polysporous cultures are multinucleate. Abnormal clamp connections are produced in connection with cell division in the multinucleate cells.

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PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XXVIII. A NEW HELOTIUM [1]

Fred J. Seaver

(with 1 figure)

Since 1912 a species of *Helotium* has been collected or observed year after year on the seeds of sour-gum, *Nyssa sylvatica,* in the New York Botanical Garden. This has occurred quite abundantly under one particular tree. It is similar to *Helotium fructigenum,* which occurs on acorns and hickory nuts, but the spores are slightly larger, which with its persistent habitat leads the writer to believe that it is a distinct species. It is, therefore, submitted as a new species.

Helotium nyssicola sp. nov.

Apothecia gregarious or occasionally occurring singly, stipitate or subsessile, reaching a diameter of 2–4 mm., pale-yellow, orbicular or with the margin irregularly split; hymenium concave or nearly plane pale-yellow; stem very slender, short or reaching a length of 2 or more cm., the length depending upon the depth of the substratum; asci clavate, reaching a length of 125 μ and a diameter of 8 μ, gradually tapering below into a slender stem-like base, 8-spored; spores fusoid or clavate, about 5–5.5 × 15–20 μ, containing a number of small granules; paraphyses rather stout granular, reaching a diameter of 3–4 μ.

Apotheciis gregariis vel solitariis, stipitatis vel subsessilibus, disco concavo vel subplano dilute flavo, 2–4 mm. diam.; stipitibus brevibus vel elongatis, gracilibus, ad 2 mm. long.; ascis clavatis, ad 125 μ long. et 8 μ diam., sporis 8, clavatis vel subfusiformibus, 5–5.5 × 15–20 μ; paraphysibus ad 3–4 μ diam. In seminibus sepultis *Nyssae sylvaticae.*

On buried or partially buried seeds of *Nyssa sylvatica.*

[1] This paper is preliminary to a monograph of North American Cup-fungi (inoperculates), a companion volume to North American Cup-fungi (operculates), which was published by the author and issued in December, 1928.

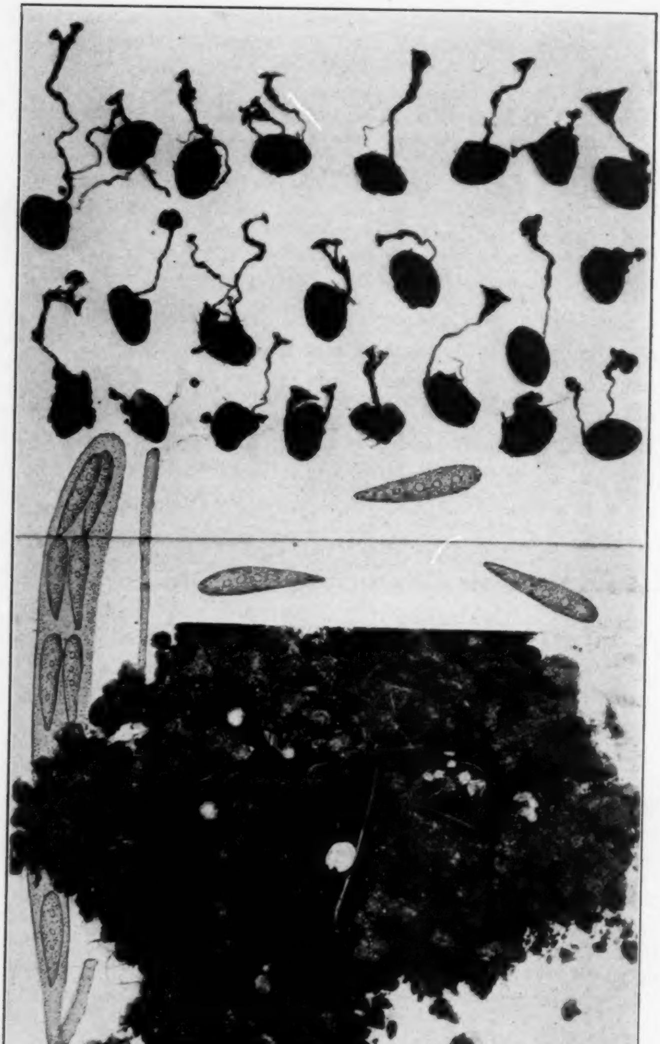

FIG. 1. *Helotium nyssicola.*

Type collected in the New York Botanical Garden, September 19, 1912. The species has appeared regularly in the same place since, coming into fruit in September. It has never been found here on any other substratum.

THE NEW YORK BOTANICAL GARDEN

EXPLANATION OF FIGURE

FIG. 1. *Helotium nyssicola.* Above, photographs of a number of seeds of *Nyssa sylvatica* with apothecia, removed from the soil, about natural size; below, photographs of apothecia as they appear above the soil; left, drawing of ascus with spores and paraphyses, near center, drawings of three spores, isolated. Photographed from type material collected near the Museum Building of the New York Botanical Garden.

A FURTHER STUDY OF THE DRY-ROT DISEASE OF OPUNTIA[1]

B. O. Dodge

(WITH 5 FIGURES)

As pointed out in an earlier note on a "dry-rot" disease of *Opuntia*[2] the spots tend to run together so that the infected side is completely destroyed if the spots are not too far apart, and are rather numerous (FIG. 1). The parasite must grow rather rapidly at first. When plants like the one shown in the figure were brought to the laboratory for study it was noticed that the spots did not seem to increase very much more in size even after several weeks. Sections extending from healthy through to the diseased tissue disclosed the reason for this. After a certain period following infection the fungus becomes completely cut off from the healthy tissue on all sides by a well marked callus tissue consisting of three or four layers of cells (FIG. 2, *a*). Wolf[3] described a similar reaction of the host against the advance of the parasite *Hendersonia Opuntiae,* the cause of "sun scald" of the prickly-pear, the main difference being that in the scald disease the suberized layers are laid down parallel to the hypodermis, while in our disease the callus cuts in obliquely from the epidermis, beginning just beyond the limits of hyphal growth, extending down under the diseased tissue and up obliquely again on the opposite side of the spot. Because of the callus, the disease does not usually extend completely through the segment. This differentiates it from the *Sphaerella* disease described by Wolf and others, a

[1] The writer is indebted to Dr. F. A. Wolf who has examined our material and has gladly offered valuable comment; and to Frank Paladino for the preparation of slides for this study. Thanks are also due to Dr. J. M. Waterston, Department of Agriculture, Bermuda, and Dr. W. H. Diehl of the Office of Mycological Collections for specimens for study. Dr. F. J. Seaver of our own herbarium has also coöperated generously in obtaining material for study.

[2] Jour. N. Y. Bot. Gard. **28**: 170–172. 1937.

[3] Ann. Myc. **2**: 113–134. 1912.

FIG. 1. Dry rot of *Opuntia*.

disease which is common in Texas and no doubt elsewhere in the south wherever *Opuntia* is found.

With one exception to be noted later, the only fruiting bodies which developed on the "dry-rot" spot are minute black pycnidium-like structures thickly scattered over the diseased area. These pycnidia give much of the black color to the spot. The bulk of the mycelium consists of thick-walled brown hyphae that invade the epidermal layer causing it to collapse so that the parasite and its fruit bodies appear to be subcuticular (FIG. 2, *b, c*). The cells of the hypodermal layer contain large rosette calcium oxalate crystals. If one follows serial sections he will find that the hyphal strands grow down into the substomatal cavities so that there must usually be some hyphal connection between the superficial fruit bodies and the deeper underlying host tissues, although the connecting strands may be rather remote, that is, not directly underneath the pycnidia as shown in figure 2, *d*. In case of anthracnose, as well as with the ascocarpic stage, *Mycosphaerella,* as described by Wolf, the dense stromata filling the substomatal cavities are characteristic (FIG. 5, *c–e*).

I am calling the fruiting structures of the dry-rot disease pycnidia for convenience. They may be spermogonial bodies. The cavities develop in a sort of stroma. The few hyaline spores matured are minute, one-celled, and rod-shaped, about $1–1.5 \times 2–4\ \mu$. Two or three cavities may form in one stroma as shown in our figure 2, *c, d*. We have observed several different badly spotted segments of *Opuntia* for a number of weeks and have never found any other fruit bodies such as those of a *Gloeosporium, Mycosphaerella, Hendersonia,* or *Perisporium,* except on one spot where a number of large superficial pycnidia of a *Fusicoccum* type were formed. They may have developed from a secondary infection or as a contaminant. They showed well developed conidiophores bearing hyaline spores which give one the idea that they must be 2-celled. The pycnidial cavity may start as two or three locules in the stroma and these later run together. There is probably no connection whatever between this fungus and the one causing the spots.

We isolated cultures from tissue transplants of the dry-rot several times and always obtained a slow-growing, thick-walled,

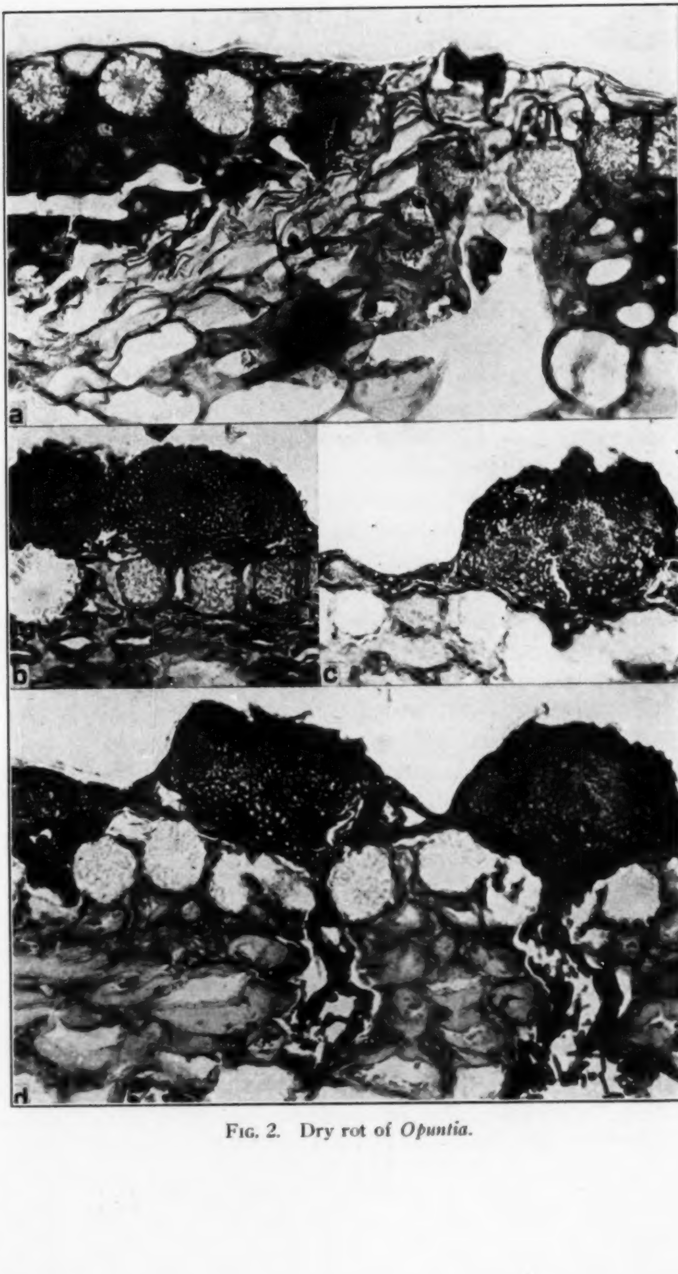

FIG. 2. Dry rot of *Opuntia*.

olive-green to brown mycelium. The results of the few inoculations of other species of *Opuntia* with the isolate were mostly negative. In no case did well-marked spots with the beautiful brown borders such as shown in the photograph ever develop. Wolf (l.c.) had difficulty in infecting *Opuntia* with conidia of *Gloeosporium lunatum* unless he placed the spores in wounds.

As to the identity of our fungus or its place in the system, little can be said. Nothing exactly like it on *Opuntia* has been described. Seaver [4] reported finding a fungus *Phyllosticta Opuntiae* Sacc. on *Opuntia* in Bermuda. Later [5] he described the fungus as *P. concava* Seaver because he had found that his fungus was not *P. Opuntiae* Sacc. The dead spots he says are similar to those caused by *Sphaerella Opuntiae* Ellis & Ev. Our fungus from New Mexico may be the same thing. The only specimen of *P. concava* we have seen is in the herbarium of The New York Botanical Garden filed under the numbers *1281* and *1287*, Bermuda Fungi. The former is a typical *Sphaerella Opuntiae* rot which extends through the segment, fruiting on both sides of it. We were unable to find any pycnidia on this particular specimen. It looks like Ellis' *Sphaerella*, as Seaver pointed out, both superficially and in section (FIG. 5, *c*). Specimen No. *1287* bears an entirely different ascomycete, probably a new species with small scattered ascocarps. The ascospores are brown but are shaped much like those of *Plowrightia morbosa*. The septation of the spore is peculiar and needs further study. The disease, if any, which was caused by this fungus is superficial. The fungus may have been purely saprophytic.

THE WATERSTON BERMUDA SPECIMENS

On the theory that Seaver's original description must have been drawn from another specimen, if not from a specimen of an entirely different disease, we asked him to try to get us more material from Bermuda. Dr. J. W. Waterston, at his request, sent us five very fine specimens of diseased *Opuntia Dillenii* (Ker.) Haw. These five specimens I have numbered separately Nos. 1–5. In each case the black spot disease penetrates completely through the

[4] Mem. N. Y. Bot. Gard. **6**: 509. 1912.
[5] N. Am. Flora **6**: 13. 1922.

thick segment. Perhaps a brief note on each specimen may be worth recording here.

Figure 3 was made from a photograph of No. *3* enlarged about four times. The white central spot represents the effect of some secondary contaminant fungus, the other spot is merely the mound of fine spines which had been cut away. The blackish central part is thickly covered with pycnidia of *Phyllosticta concava* Seaver (?). Surrounding this portion are two or three indefinite rings of pinkish pycnidia which have burst through the epidermis. Within these zythiaceous fruit bodies one finds numerous long conidiophores and great masses of small spores about 1–1.5 × 3–4.5 μ. Similar fruit bodies are scattered through the black part of the spot. They are often deep-seated (FIG. 4, *d*), but the spore mass usually connects up with a substomatal cavity so that dispersal is possible before the segment disintegrates entirely. Frequently these pycnidia are more superficial and then the opening has something of the appearance of a true ostiole. That the pycnidium is cleistocarpic and not ostiolate is evident from the sections in figure 4, *b* and *c*. The section at *c* was cut through the center of the pycnidium. The wall had just split open. As growth proceeds the opening is widened further by the upward thrust of the spore mass. The overlying cuticle is visible in this photograph. Figure 4, *b*, is from a section a little to one side of that shown in *c*. Conidiophores extend inward from all directions. The whole cavity it would seem is originally lined with fertile cells. Figure 4, *d*, shows an older deep-seated pycnidium. At the right can be seen the substomatal cavity into which spores are being extruded.

Because of the bright-colored, globoid, fleshy pycnidium, this fungus would be classed in the Zythiaceae. According to Clements and Shear it would come under the genus *Leptodermella* of which the type is *Zythia incarnata* Bres. The spores of that species, however, are very much larger. We shall therefore refer to our fungus, temporarily at least, as a species of *Leptodermella*.

Leptodermella Opuntiae sp. nov.

Pycnidia pinkish, fleshy, at first globoid, then somewhat flattened, 100–170 μ in diam., non-ostiolate, the wall splitting open above, either deep-seated, discharging spores into substomatal cavities, or

more superficial, discharging spores directly through the erupted epidermis; conidiophores numerous, filiform; conidia hyaline, 1-celled, faintly colored in mass, 1–1.5 × 3–4.5 μ.

Pycnidiis roseis, carneis, primo sub-globosis, 100–170 μ diam., astomis; conidiophoriis filiformibus; conidiis hyalinis, cylindraceis, 1–1.5 × 3–4.5 μ.

On *Opuntia Dillenii*, Devonshire, South Shore, Bermuda, April 25, 1937. Col. J. M. Waterston.

Type specimen No. *3* of the Waterston Bermuda specimens in the herbarium of The New York Botanical Garden.

FIG. 3. *Leptodermella Opuntiae* and *Phyllosticta concava?*

The type specimen of *Nectriella Cacti* Ellis & Ev., *Hyponectria Cacti* (Ellis & Ev.) Seaver, on *Opuntia* bears what seems to be a rather pure stand of ascocarps. Another specimen, co-type, having the same number *584*, bears numbers of pycnidia which, though darker-colored, have much the same characteristics as our *Leptodermella*. Sections of pycnidia give the same general morphology.

They are astomous, splitting above and opening out to discharge their spores. They are exactly like the pycnidium shown in our figure 4, *d*, although they are not so deeply embedded, no doubt due to host differences. A connection between a zythiaceous pycnidial stage and an ascocarpic form in the *Nectria* group would not be strange. The presence of such a stage on an *Opuntia* along with *Hyponectria* and *Mycosphaerella* emphasizes the need still more, as will be noted later, for a thorough study of the life histories of the fungi involved in *Opuntia* diseases.

The Waterston specimen No. *5* shows a similar black spot extending completely through the segment. The spot is bordered at one side by a few scattered pycnidia of the *Leptodermella*. Sections of the black portion of the spot show young ascocarps (FIG. 4, *a*) of a fungus similar to *Sphaerella Opuntiae* Ellis & Ev. Not many ascocarps had as yet matured asci. As Wolf pointed out, it is doubtful if such ascocarps, especially when there are more than one in a stroma, should be placed in the genus *Mycosphaerella*. They are very often single, however, in this material. Just what is a stroma and what is not a stroma no one yet has been able to define satisfactorily.

The Waterston specimen No. *2* bears mature perithecia of a *Mycosphaerella* and a few of the pinkish pycnidia of the *Leptodermella* mentioned above, as does specimen No. *4*. Specimen No. *1*, however, bears mature ascocarps of "*Mycosphaerella*" but none of the pink pycnidia. If one examines carefully any one of these specimens he will be able to pick out here and there small black pycnidia of the kind which completely cover the black spot of No. *3*. They have very small spores.

If Nos. *3* and *5* spots were caused by the same fungus we would have the *Leptodermella* with its large waxy deep-seated type of pycnidium which is at first cleiostocarpic, and the small spermogonium-like pycnidium (*Phyllosticta concava?*) both connected with the perfect form "*Mycosphaerella*." Assuming that Wolf proved the connection (although he does not claim to have done this by single spore cultures) between *Gloeosporium lunatum* and *Mycosphaerella Opuntiae*, then the Waterston material must represent a new species of *Mycosphaerella* with altogether different types of asexual fructifications. Too much faith must not be

FIG. 4. Sections of fungi on *Opuntia*.

placed on association of spore forms. It was interesting to find[6] *Hendersonia Opuntiae* and *Leptosphaeria Opuntiae* associated. This may have been purely accidental. We have seen the *Hendersonia* on *Opuntia* without the *Leptosphaeria*.

SPHAERELLA OPUNTIAE AND GLOEOSPORIUM LUNATUM

The type specimen of *Gloeosporium lunatum* Ellis & Ev. in our herbarium has a number of tubercle-like "acervuli" bearing crescent-shaped 2-celled spores reminding one more of a *Fusarium*. There are also a number of whitish more patellate fruiting structures bearing masses of smaller non-septate spores. Wolf has pointed out that the young spores of *G. lunatum* are not septate. On the edge of the type specimen are a number of perfectly good pycnidia (*Phyllosticta concava?*). We could find no perithecia. The part of the segment bearing the "*Gloeosporium*" certainly shows no black stroma-like growths. Wolf has shown that stromata bearing acervuli are at first not dark-colored, but later turn brown or blackish in preparation for the formation of perithecia.

Wolf furthermore says of the anthracnose which is connected with *Mycosphaerella Opuntiae:* "Quite commonly a zone of brown marks the body of the anthracnose area." No such brown zone is evident now in any of the material which I have examined from Texas and Bermuda and in the herbaria of the Mycological Collections, U. S. Department of Agriculture and ours, but it might have shown in the material when it was fresh. In spite of this common character I can not believe that our dry-rot disease is the same as Wolf's anthracnose caused by *Gloeosporium lunatum*. In our material the size of the spot is soon limited by the very definite callus layer so that it seldom penetrates completely through the segment, which seems to be very characteristic of the Bermuda specimens as well as those from Texas and elsewhere.

OTHER SPECIMENS

Sections of a specimen in the herbarium of Mycological Collections, U. S. D. A., of *Mycosphaerella Opuntiae* from Tuskegee, Alabama, collected by Carver bear rather superficial perithecia

[6] Mycologia **29**: 707–716. 1937.

(FIG. 5, *b*) which are not developed in such complex stromata. This may be a different species. One finds occasionally in the Carver specimen very small bodies (FIG. 5, *a*) like our "spermogonia."

Below is one set of comparative measurements of perithecial structures of the Wolf and Carver specimens of *Mycosphaerella Opuntiae:*

	Wolf	Carver
Thickness of stromatic wall	50–100 μ	30 μ
Diameter of cavity	100–120 μ	60–70 μ
Ascus dimensions	60 × 12–15 μ	50–55 × 10–12 μ
Spores	20–22 × 3.5–4 μ	14–16 × 2–2.5 μ

Compare above Fig. 5, *b*, 5, *e* and 4, *a*.

Figure 5, *d*, is from a section of a specimen in our herbarium labeled *Gloeosporium Opuntiae* collected by Dietrich in Mississippi. The black stromatic tissue is marked below by empty cavities while above there are centers of disorganization which seem to indicate that ascocarps are about to be developed. This would be in accord with Wolf's finding for *G. lunatum*. He says that perithecia develop from the stromata which formerly bore acervuli at the top. We found no *Gloeosporium* on these spots which are very small and much like those of our dry-rot fungus shown in figure 1, except that the disease penetrates clear through the segment.

A box of beautifully diseased specimens of *Opuntia* has just been received from Mr. Elwyn Moses of Fort Pierce, Florida. Superficial examination shows that this disease is entirely unlike any of *Opuntia* so far seen by the writer. This collection will be studied and reported on later.

Other specimens from various sources have been examined only to add further to the confusion. Obviously there are at least two black spot diseases that penetrate the segment, fruiting on both sides. In some specimens ascocarps, or their fundaments, which have been placed in the genus *Mycosphaerella,* prevail. In other specimens pycnidia referable to *Phyllosticta concava* Seaver prevail. *Leptodermella Opuntiae* has been found associated with both of these types of fruits. On the other hand, Wolf made such a thorough study of "anthracnose" of *Opuntia* in Texas that there can be no doubt *Gloeosporium lunatum* and *Sphaerella Opuntiae* are connected.

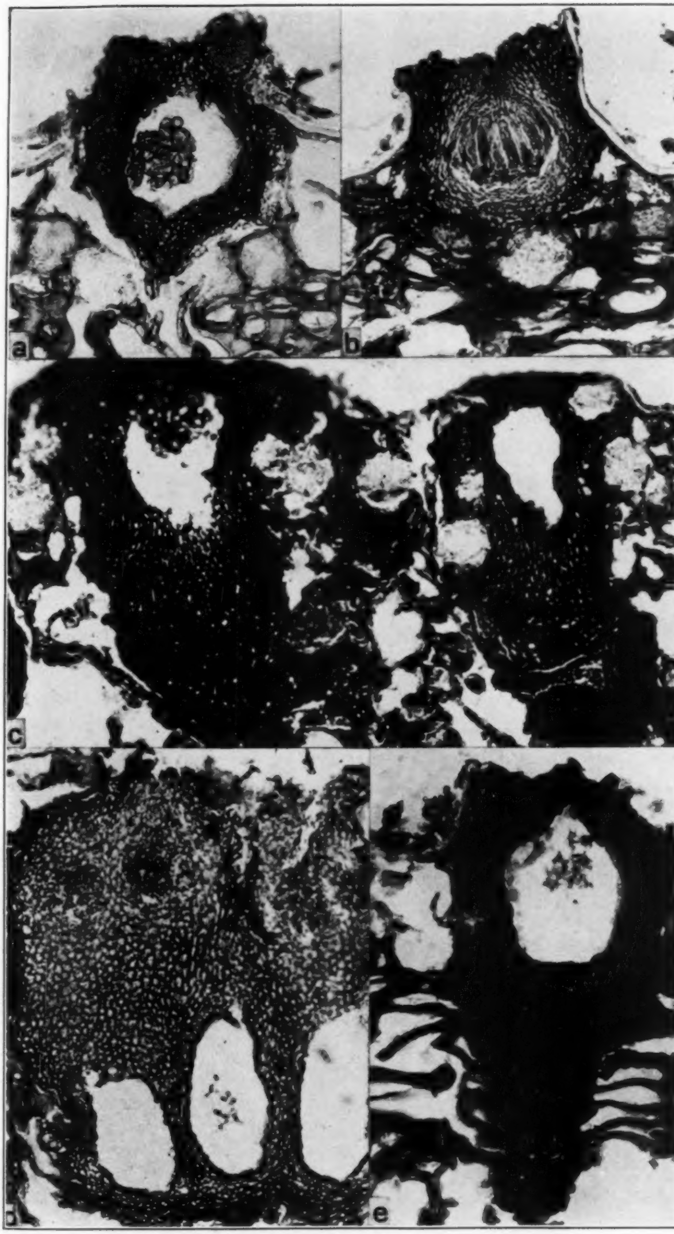

FIG. 5. *Mycosphaerella Opuntiae.*

SUMMARY AND CONCLUSIONS

A black-spot dry-rot of an unidentified species of *Opuntia* from New Mexico, which recently appeared in our greenhouses, has been studied with reference to the host parasite relationship, the identity of the fungus causing the disease and its relationship to other fungi causing similar diseases of other species of *Opuntia.* The invasion of the host by our species is at first fairly rapid but, as the spots become enlarged, the host reacts to prevent further invasion by the formation of a callus layer cutting off the healthy tissue from the advancing parasite. The only fruiting bodies so far developed are minute black pycnidium-like structures which are possibly spermogonia, the cavities of which are developed in stromatic tissue through disorganization. It is possible that this or a similar fungus formed the basis for Seaver's *Phyllosticta concava.* A comparison has been made with diseased material from Texas, Bermuda and other regions in the South. No fruiting bodies of anthracnose have been found on our diseased *Opuntia.* The Bermuda specimens from Waterston bear three or four different types of fruiting bodies. The type most commonly present is the one that has the superficial appearance of a *Gloeosporium.* It has been called *Leptodermella Opuntiae.* It is a true pycnidium which is at first cleistocarpic. Four of these specimens show perithecia which may belong to some *Mycosphaerella.* The other specimen, No. *3,* bears not only the *Leptodermella* pycnidia but also great numbers of small black pycnidia of the type described by Seaver as *Phyllosticta concava.*

It would be desirable to be able to identify our dry-rot fungus or at least to attach some name to it even though it might later be proved to be either a spermogonial or a pycnidial stage of some *Mycosphaerella.* For the present it can be referred to as *Phyllosticta concava?* Seaver, although the fruiting body is certainly not that of a typical *Phyllosticta.* Our present purpose will have been fulfilled if it has been demonstrated that there is still important work to be done before the life histories of the several fungi causing diseases of *Opuntia* are fully cleared up. The Waterston Bermuda material alone proves that as yet we know very little about the fungi involved. Those who live in regions where

Opuntia thrives, in spite of its diseases, have an opportunity to make a worthwhile contribution to mycology and pathology.

EXPLANATION OF FIGURES

FIG. 1. The "dry-rot" disease of *Opuntia* sp. from New Mexico. The characteristic brown zone bordered by a paler zone surrounding each spot is plainly visible in the spots on the upper segment. The lower segment shows where a number of spots have grown together so that most of the segment on this side was destroyed. The black part of each spot was thickly covered by minute pycnidium-like fruiting bodies. These also appeared, but in fewer numbers, on the brown zones. Both segments later became concave-convex as noted in the paper referred to in the text.

FIG. 2. Sections through one of the smaller lesions. *a*. This section shows the callus layer beginning at the right, around the stoma, and extending obliquely downward to the left. The substomatal cavity at the right. The difference between the invaded and non-invaded host tissues is brought out by the contrasting color, the part bearing hyphae being black. *b*. Section through stroma-like masses in which small pycnidial cavities are being developed through disorganization of the central tissue, the hypodermal layer bearing the large calcium oxalate crystals just beneath the fruiting bodies. *c*. At the left the hyphae extending out from the stromatic mass invading the epidermal cells which they have destroyed. At the right three cavities being developed in the same spermogonial stroma. *d*. Two fruiting bodies, each with two or three cavities containing spores, and dark brown hyphal strands extending down into the substomatal cavities. Hyphae penetrating between the mesophyll cells are also visible.

FIG. 3. From a photograph of the spot on a segment of *Opuntia Dillenii* enlarged about four times. (No. 3 of the Waterston Bermuda collection referred to in the text.) The upper central spot is merely a mound of spines, the lower central spot apparently the effect of some secondary contaminant fungus. The minute black bodies covering the central part are pycnidia, possibly those of *Phyllosticta concava* Seaver. Surrounding the black central region are two or three indefinite zones of pinkish, erumpent fruiting bodies of *Leptodermella Opuntiae* which would be referred to as a *Gloeosporium* if they were not studied in section. See figure 4, *b–d*.

FIG. 4. *a*. Section through a portion of the spot of *Mycosphaerella Opuntiae* from the Carver specimen in the herbarium of Mycological Collections, U. S. D. A. Not infrequently two or three perithecial cavities are developed in the same stroma. Asci had not been formed as yet in this section. *b*. Section a little to one side of the center of one of the pinkish pycnidia (*Leptodermella Opuntiae*) showing conidiophores extending toward the center from all directions. *c*. Section of the same pycnidium through its center showing a break just beneath the cuticle through which spores will later be discharged. This is not an ostiole. *d*. Section of a more deeply-seated pink pycnidium showing how the wall has been shoved aside by the central spore mass which is extruding spores into the substomatal cavity at the right. *e, f*. Sections through "pycnidia" from the spot shown in figure 3, which is from specimen No. 3 of the Waterston Bermuda collection. Such a specimen may have been the basis for Seaver's *Phyllosticta concava*.

FIG. 5. *a*. Section through an aborted (?) ascocarp of "*Mycosphaerella Opuntiae*" from the Carver collection mentioned in the text. At the upper right a small "spermogonium" bearing minute spores. *b*. Mature ascocarp from the same specimen as *a*. The smaller size of the perithecia, their more superficial location and the lack of the conspicuous black stromatic masses characteristic of *Mycosphaerella Opuntiae*, as figured by Wolf and as seen from our photograph from a section of his material (FIG. 5, *e*), should differentiate this species from true *Mycosphaerella Opuntiae*. *c*. Section through specimen 1281 collected by Dr. F. J. Seaver in Bermuda and labeled in our herbarium *Phyllosticta concava*. These black stromatic masses with irregular cavities no doubt represent perithecial stromata of some *Mycosphaerella*. *d*. Section through part of a specimen labeled "*Gloeosporium Opuntiae*" collected by Dietrich and placed in our herbarium. The irregular cavities in the lower part of a stroma are not easily explained but the spots in the upper part of the mass evidently indicate disorganization which will lead to the development of perithecial cavities just as Wolf described for *G. lunatum*. *e*. Section through an old ascocarp of *Mycosphaerella Opuntiae* from a specimen collected by Wolf, and placed in our herbarium (see text for further explanation).

NEW RECORDS OF HAWAIIAN DISCOMYCETES

Edith K. Cash

(with 6 figures)

The extensive fungus collections made in the Hawaiian Islands during the winter of 1927–1928 by Drs. C. L. Shear and N. E. Stevens include a considerable number of discomycetes, a group heretofore very little known from this region. Additional specimens from the herbarium of Mr. Otto Degener, a well-known phanerogamic botanist of the Islands, were also examined. A study of this material has yielded data of interest, since it extends the known range and adds new hosts for a number of discomycetes already described, and also includes six species here described as new. F. L. Stevens (**4**) notes only five species of Pezizales in his catalogue of Hawaiian fungi; the present paper discusses thirty-five, only one of which was included by Stevens, the rest being reported from this locality for the first time.

STICTIDACEAE

1. Propolis faginea (Schrad.) Karst. On herbaceous stems. Iao Valley, Maui, S. & S. *597.*[1]

2. **Schizoxylon Abutilonis** sp. nov. (fig. 3).

Apothecia urceolate, immersed, numerous, completely covering swollen areas of bark in patches 2–3 cm. in length, round to elliptical or distorted in outline, 0.5–1 mm. diam., margin narrow, white, thin, entire or only slightly lacerate, hymenium at first covered by a pulverulent, light olive-gray (R), Pl. 37 A1 (MP) [2]

[1] Specimens collected by Shear and Stevens are indicated as "S. & S.," those from the Degener Herbarium as "D." The specimens are deposited in the Mycological Collections of the Bureau of Plant Industry, Washington, D. C.

[2] "R" in color citations refers to Ridgway, Color Standards and Color Nomenclature, Washington, 1912; "MP" to Maerz and Paul, A Dictionary of Color, Ed. 1, New York, 1930.

membrane with a small central pore, later opening to expose the deeply sunken hymenium, which is Capucine buff (R), Pl. 9 E5 (MP) when moist, drying Capucine yellow to Mikado orange (R), Pl. 9 K8–J8 (MP); asci cylindrical, 150–175 × 5–6 μ, the tips blue with iodine; spores nearly as long as the asci, 1–1.5 μ in diameter, breaking up in the ascus into cells 1–1.5 μ square; paraphyses filiform, unbranched, 1 μ in diameter, undulate at the tips.

Apotheciis dense congregatis, immersis, urceolatis, 0.5–1 mm. diam., margine albo, angusto, fere integro, hymenio primum membrana grisea tecto, dein exposito, aurantio; ascis cylindraceis, 150–175 × 5–6 μ; sporis ascorum longitudine, linearibus, 1–1.5 μ diam., mox in articulos 1–1.5 μ longos secedentibus; paraphysibus filiformibus, non ramosis, apice undulatis, 1 μ diam.

On stems of *Abutilon molle*, N. Honolulu, Jan. 18, 1928, S. & S. *551.*

With the exception of *Schizoxylon Berkeleyanum* (Dur. & Lév.) Fuckel, a species distinctly different from this fungus, no species of *Schizoxylon* has been reported on Malvaceae. *S. aduncum* Feltg., described on *Silene* in Europe, has somewhat similar dimensions, but appears to differ in sparse apothecia, black exterior and hymenium, and entire spores. No material of Feltgen's fungus is available for comparison.

3. Schizoxylon insigne (De N.) Rehm. On stems of *Lantana* sp., Manoa Valley, Oahu, S. & S. *553*. *Lantana* is a new host for this species.

4. **Stictis hawaiensis** sp. nov. (fig. 1).

Apothecia sparse, urceolate, deeply immersed, 0.3–0.5 mm. diam. and deep; hymenium Baryta yellow (R), Pl. 9 I1 (MP), drying orange-yellow to light ochraceous-salmon (R), Pl. 11 K6–C6 (MP), margin smooth, white, usually entire, sometimes slightly lacerate; asci clavate-cylindrical, non-pedicellate, 8-spored, 175–200 × 13.5–15 μ, narrowed to 8–9 μ at the apex, the wall thickened and becoming faintly blue with iodine; spores cylindrical-fusoid, hyaline, parallel, narrowed at the ends, nearly the length of the asci, 3–4.5 μ diam., 50–60-septate, slightly constricted at the septa, cells 2.5–3.5 μ long; paraphyses filiform, unbranched, guttulate, 1 μ diam., slightly thickened at the apex, forming a greenish epithecium.

Apotheciis sparsis, urceolatis, immersis, 0.3–0.5 mm. diam. et profundo; hymenio flavo, margine levi, albo, angusto, sublacerato; ascis clavato-cylindricis, octosporis, 175–200 × 13.5–15 μ, apice angustatis, sporis cylindrico-fusoideis, hyalinis, parallelis, ascorum longitudine, 3–4.5 μ diam., 50–60-sep-

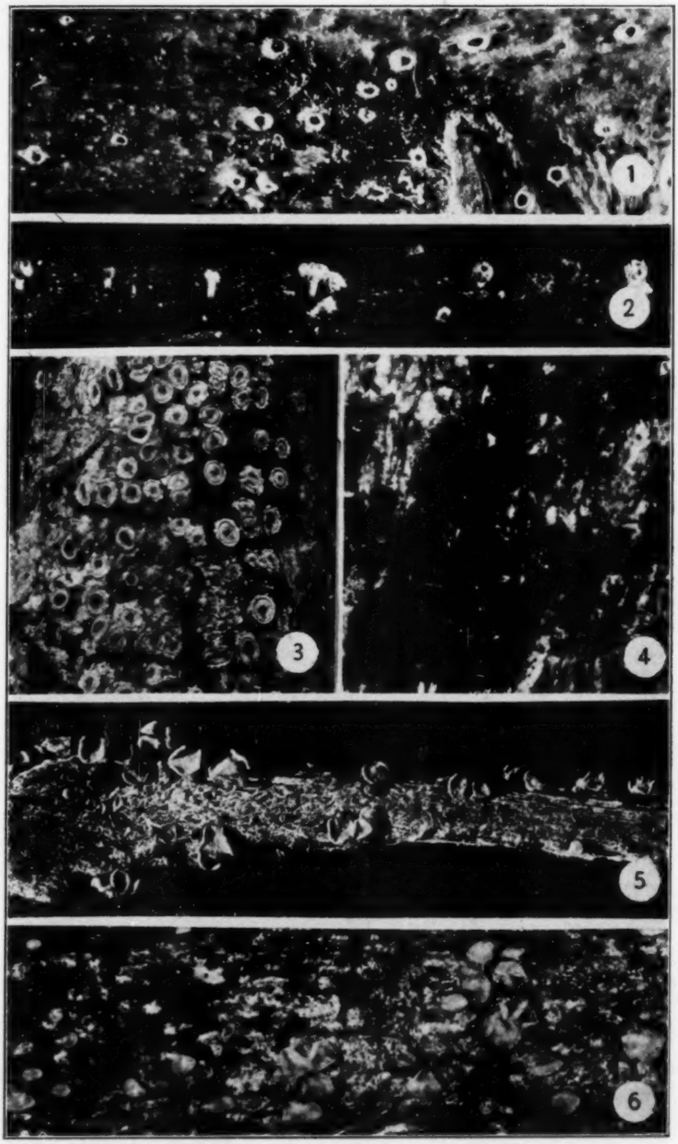

FIG. 1, *Stictis hawaiiensis;* 2, *Lachnum Gleicheniae;* 3, *Schizoxylon Abutilonis;* 4, *Scleroderris Lantanae;* 5, *Mollisia petiolaris;* 6, *Orbilia Abutilonis.*

tatis; paraphysibus filiformibus, non ramosis, guttulatis, 1 μ diam., epithecium subviridem formantibus.

On living stems of *Rubus rosaefolius,* Byron Trail, Kilauea, Oct. 15, 1929, D. *3776.*

The hymenium of *Stictis Rubi* Schw. is black, and there is no white margin; other species of the genus reported on *Rubus, S. stellata* Wallr., *S. radiata* (L.) Pers. and *S. arundinacea* Pers., all have narrow spores. The collection notes record this fungus as occurring "on living *Rubus rosaefolius,* which is now being killed throughout the region," but the *Stictis* is in all probability secondary.

5. STICTIS RADIATA (L.) Pers. On stems of *Sadleria* sp., Waihee Valley, Maui, S. & S. *546;* on stems of *Cibotium* sp., Olinda Pipe Line, S. & S. *548.* In both of these specimens the margin of the apothecia is narrower and more nearly entire than that described for *S. radiata,* but other characters agree. This species has been reported on ferns.

6. S. RADIATA subsp. S. INTERMEDIA Speg. On stem of *Abutilon molle,* N. Honolulu, S. & S. *550.* Several forms of *S. intermedia* are noted in Saccardo, varying in color, character of the margin, and size of asci and spores. The material on *Abutilon* is nearest to form "b."

7. STICTIS STELLATA var. PHILIPPENSIS Rehm. On stems of *Verbena bonariensis,* Kokee, S. & S. *543.* No species of *Stictis* has been reported on *Verbena.* The material is referred to this Philippine variety of *S. stellata,* with which it agrees in the thickness and septation of the spores.

DERMATEACEAE

8. **Scleroderris Lantanae** sp. nov. (FIG. 4).

Apothecia erumpent, caespitose, sessile, coriaceous, cupulate to patellate, contorted by mutual pressure, 1–1.5 mm. diam., exterior furfuraceous, mummy brown (R), Pl. 8 E11 (MP), covered with flexuous brown hyphae 1 μ in diameter; margin thin, sulcate, inrolled when dry, sometimes folded longitudinally, giving a hysteroid appearance; hymenium fuscous to fuscous black (R), Pl. 8 H7–C7 (MP); hypothecium prosenchymatic, yellow; cortex dark brown, thick, irregularly lacerate; asci clavate, rounded at the apex,

gradually narrowed toward the base, 8-spored, 50–55 × 5 μ; spores biseriate, fusoid, acute at the ends, straight or slightly curved, 2–4-guttulate to 1-septate, hyaline to pale brownish, 11–17.5 × 1.5–2 μ; paraphyses septate, unbranched, 2.5 μ at the apex, forming a dark greenish-brown mazaedium.

Apotheciis erumpentibus, caespitosis, sessilibus, coriaceis, cupulatis vel patellatis, contortis, fusco-atris, furfuraceis, 1–1.5 mm. diam.; margine acuto, sulcato, involuto vel hysteroideo; hymenio brunneo vel atro; ascis clavatis, apice rotundatis, base attenuatis, octosporis, 50–55 × 5 μ; sporis biseriatis, fusoideis, acutis, rectis curvatisve, 2–4-guttulatis vel 1-septatis, hyalinis vel pallide brunneis, 11–17.5 × 1.5–2 μ; paraphysibus septatis, non ramosis, apice 2.5 μ, mazaedium viridi-brunneum formantibus.

On fallen branch of *Lantana camara,* Kaluaaha Valley, Molokai, July 12, 1928, D. *3032.*

9. TRYBLIDIELLA RUFULA (Spreng.) Sacc. On dead stems of *Leucania glauca,* Pipe Line above Lahaina, Maui, S. & S. *567;* on dead twigs of *Prosopis* sp., Pukoo, Molokai, D. *3015;* on fallen branches of *Cassia bicapsularis,* Kaluaaha Valley, Molokai, D. *3024, 3025, 3037.*

BULGARIACEAE

10. CALLORIOPSIS GELATINOSA (Ellis & Mart.) Syd. On mycelium of Perisporiaceae on living leaves and stems of *Scaevola* sp., Kokee, S. & S. *569;* Castle Trail, Oahu, S. & S. *540;* Kohama Valley, S. & S. *539;* on living leaves of *Wikstroemia* sp., S. & S. *538.*

11. CORYNE SARCOIDES (Jacq.) Tul. on wood of *Aleurites,* Kona, S. & S. *571.* No previous record has been found of the occurrence of *C. sarcoides* on *Aleurites.*

12. **Orbilia Abutilonis** sp. nov. (FIG. 6).

Apothecia superficial, gregarious, thin, gelatinous, shrinking when dry, sessile, orbicular, concave to patellate, smooth, 0.4–1 mm. diam., attached to the host at the base by delicate white mycelial threads, pale ochraceous buff to pinkish buff (R), Pl. 10 B3–C4 (MP), drying light ochraceous salmon to avellaneous (R), Pl. 10 B6 to Pl. 13 B6 (MP), margin crenate; asci cylindrical-clavate, truncate, 8-spored, 25–28 × 3–3.5 μ; spores uniseriate, allantoid to nearly spherical, hyaline, 2 × 1.5–1.7 μ; paraphyses filiform, gradually enlarged at the apex to 2.5 μ; hypothecium thick, hyaline; exciple hyaline, composed of large, globose, thin-walled cells.

Apotheciis superficialibus, congregatis, tenuibus, gelatinosis, sessilibus, orbicularibus, concavis vel patellatis, laevibus, 0.4–1 mm. diam., pallide ochraceo-roseis, siccis avellaneis, margine crenato; ascis cylindrico-clavatis, truncatis, octoporis, 25–28 × 3–3.5 μ; sporis uniseriatis, allantoideis vel fere sphaericis, hyalinis, 2 × 1.5–1.7 μ; paraphysibus filiformibus, apice 2.5 μ; hypothecio crasso, hyalino; cortice cellis magnis hyalinis globosis composito.

On stems of *Abutilon molle*, N. Honolulu, Jan. 18, 1928, S. & S. *552*.

13. ORBILIA EPIPORA (Nyl.) Karst. On log of *Artocarpus incisa*, Mauamaua Bridge, beyond Haua, E. Maui, S. & S. *598;* on log of *Mangifera indica*, Hahalewe, E. Maui, S. & S. *576;* on hymenium of polypore, Pupukea, Oahu, S. & S. *577*. Both *Artocarpus* and *Mangifera* are new hosts for the fungus.

14. ORBILIA LEUCOSTIGMA Fries. On wood of *Psidium guajava*, Manoa Valley, Oahu, S. & S. *578*.

15. SARCOSOMA GODRONIOIDES Rick. On wood of *Scaevola* sp., Pupukea, S. & S. *559;* on ground under bamboos, Honolulu, Oahu, S. & S. *560;* on decayed branch, Maunahui, Molokai, D. *3100*. Except for slightly larger apothecia the Hawaiian specimens are identical with a collection made by Rick at Sao Leopoldo, Brazil, in 1931 and determined by him as this species. The writer has also recently studied a *Sarcosoma* on redwood twigs, Spruce Cove, Trinidad, California, H. E. Parks *5626,* which agrees with Rick's specimen in every character except size. The original material is described as having apothecia 3.3 mm. in diameter, contracted both toward the base and the apex, with a narrow mouth. The Rick collections, including the specimen cited above and Lloyd Mycological Collection no. *32114,* are 3–5 mm. in diameter. In the Hawaiian material the apothecia range from 5 mm. to 1 cm., while in the California specimen they are wide-opened cups measuring from 1.5 to 2.5 cm. Whether these collections represent related species differing in size, or one species showing wide variation in this respect, is difficult to determine without more abundant material. In all of these specimens the apothecia are densely clustered and attached at the base to each other and to the host by a mass of mycelium, similar to that in *Bulgaria melastoma* (Sow.) Seaver, but without the red granules of that species. The spores range from 20 to 27 μ in length and 10 to 15 μ in width, none equaling the maximum of 30 μ given in Rick's description; they

are slightly fusoid and narrow in early stages, tending to become shorter and broader as they mature. The " membrana reticulata " noted by Rick is a thick exospore characterized by ten to twelve straight or slightly undulating ridges, resembling those in some species of *Cookeina,* but transverse instead of longitudinal.

PATELLARIACEAE

16. KARSCHIA LIGNYOTA (Fries) Sacc. On dead wood, Kokee, S. & S. *595.*

17. KARSCHIA TAVELIANA Rehm. On wood of *Aleurites* sp., Kona, S. & S. *570* and Waihee Valley, S. & S. *572. K. taveliana* has not hitherto been recorded on this host.

18. PATELLARIA ATRATA (Hedw.) Fries. On stems of *Lantana* sp., Waialua, Oahu, S. & S. *574;* on stems of *Hibiscus tiliaceus,* Tantalus Road, S. & S. *596;* on dead trunk of *Erythrina monosperma,* Valley west of East Ohia, Molokai, D. *3044.* New host records for this species.

MOLLISIACEAE

19. MOLLISIA CINEREA (Batsch) Karst. On stems of *Pritchardia* sp., Kahaua Valley, S. & S. *575.* This species has not been previously reported on *Pritchardia.*

20. **Mollisia petiolorum** sp. nov. (FIG. 5).

Apothecia fleshy, patellate, sessile, 0.3–1.2 mm. diam., closely crowded along petioles and midribs, margin triangularly or irregularly involute, hymenium grenadine to carnelian red (R), Pl. 1 D11 to Pl. 2 E11 (MP), drying English red to bay (R), Pl. 4 J12 to Pl. 8 L1 (MP), or nearly black in old specimens, exterior concolorous, smooth; asci cylindrical, narrowed to the apical pore, 8-spored, 40–45 × 4 μ; spores 1–2-seriate, hyaline, unicellular, fusoid, 7–9 × 1.5–2 μ; paraphyses straight, stiff, granulose, unbranched, septate, 1.5–2 μ at the apex; hypothecium thick, hyaline, of shining, globose to irregular cells; exciple parenchymatic, brown at the base, subhyaline above, cells elongated at the margin.

Apotheciis carnosis, patellatis, sessilibus, dense aggregatis, 0.3–1.2 mm. diam., roseo-alutaceis, siccis armeniacis vel aurantio-rubris, margine involuto, extus laevis; ascis cylindricis, apice angustatis, 40–45 × 4 μ, octosporis; sporis 1–2-seriatis, hyalinis, unicellularibus, fusoideis, 7–9 × 1.5–2 μ; paraphysibus rectis, granulosis, non ramosis, septatis, apice 1.5–2 μ; hypothecio

crasso, hyalino, cellulis globosis vel irregularibus, nitentibus composito; textura excipuli parenchymatica, subhyalina, base brunnea, cellulis ad marginem elongatis composita.

On leaf petioles of *Hibiscus tiliaceus*, Tantalus, Honolulu. Dec. 1, 1927, S. & S. *554* (type), and Pali, Oahu, Feb. 6, 1928, S. & S. *790;* of *Terminalia* sp., Castle Home, Honolulu, Dec. 18, 1927, S. & S. *536;* of *Aleurites* sp., Maui, Dec. 22, 1927, S. & S. *555;* on leaf midribs of *Freycinetia* sp. (?), Tantalus, Feb. 20, 1928, S. & S. *791.*

The definitely parenchymatic exciple would refer this fungus to the Mollisiaceae. It resembles *Orbilia* in the thick layer of large, globose cells, but the texture is fleshy, not gelatinous, not shrinking noticeably when dry. The illustration of *Mollisia orbilioides* Penz. & Sacc. (**2**, pl. 47, f. 1) suggests that it is similar in structure but does not agree with the Hawaiian specimens in dimensions of spores and asci. *Pezizella orbilioides* Feltg. also appears to be a somewhat similar fungus, which, however, differs in the crenate margin and hooked paraphyses.

HELOTIACEAE

21. CHLOROSPLENIUM AERUGINASCENS (Nyl.) Karst. On decayed wood, dense woods south of Pepeopae, Molokai, D. *2931.*

22. **Dasyscypha citrino-alba** (Penz. & Sacc.) comb. nov. = *Trichopeziza citrino-alba* Penz. & Sacc. On wood of *Rhus semialata.* Iao Valley, Maui, S. & S. *579;* on cut wood of *Metrosideros polymorpha, 27* miles from Glenwood, D. *2955.* Although no specimens are available for comparison the Hawaiian material agrees so closely with the description of this species, reported from Java, that it is referred here.

23. ?DASYSCYPHA JAVANICA Penz. & Sacc. On stems of *Cibotium menziesi,* above Hilo, S. & S. *585.* The spores in this specimen are 15–18 × 1–1.5 μ, slightly more slender than the measurements given for the Javan fungus. Proliferation of the apothecia is noticeable; sterile black dots evident in the center of the young apothecia later develop into secondary cups.

24. DAVINCIA HELIOS Penz. & Sacc. On dead stems of *Eupatorium* sp. along ravine south of Haunahui, Molokai, D. *2924.* Another specimen recently collected in Panama by Dr. G. W.

Martin has been referred to Penzig and Saccardo's species. In general appearance the fungus is similar to *Cyathicula coronata* (Bull.) de Not., but in the specimens of the latter species which have been examined, the apothecia are about twice as large as *Davincia helios,* reddish to buff, not white, and the spores are unicellular or pseudoseptate, while in *D. helios* they are distinctly 3-septate and slightly constricted. It is possible that the Javan species is a form of *Belonioscypha campanula* (Nees) Rehm, which is illustrated by Boudier (**1**, pl. 500) under the name *Belonidium vexatum* De Not. with a dentate margin; on the other hand the apothecia of this species in Rabh. Herb. Myc. 419 all show smooth, entire margins. The spores are also much larger than those of *D. helios,* and clavate, so that *D. helios* would seem to be a valid species.

25. ERINELLA LONGISPORA Karst. On wood of *Mangifera indica,* Palolo Valley, S. & S. *544.* Reported from Hawaii by Stevens (**4**, p. 12).

26. HELOTIUM CREMEUM Cash. On stems of *Cibotium* sp., Olinda Pipe Line, S. & S. *549;* on stems of *Gleichenia* sp., Iao Valley, S. & S. *583;* on dead fern stipes, end of Palolo Road, and Mt. Kona, S. & S. *588* and *587.* The Hawaiian specimens appear to be identical with the type of this species, first found on *Pteridium* in California.

27. HELOTIUM SULPHURINUM Quél. On dead wood of *Aleurites,* Waihee Valley, Maui, S. & S. *573;* on dead branches, Palolo Valley, Oahu, S. & S. *599.*

28. **Lachnum Gleicheniae** sp. nov. (FIG. 2).

Apothecia developing in sunken areas of the stems, sulphine yellow to orange citrine (R), Pl. 12 L4 to Pl. 14 L7 (MP), old specimens fading to cream buff (R), Pl. 11 G3 (MP), stipitate, globose then cup-shaped, thin-fleshy, covered with yellow-brown hairs, 0.2–0.7 mm. diam., opening at first by a small circular pore, then cup-shaped and showing the sulphur-yellow hymenium; stipe smooth, 0.1 mm. diam., 0.1–0.4 mm. high; asci cylindrical, acute at the apex, 8-spored, 40–50 × 3–5 μ; spores irregularly biseriate, fusoid, hyaline, pointed at the ends, straight or slightly inaequilateral, 9–11 × 1–2 μ; paraphyses numerous, extending beyond the asci, lanceolate, 55–60 × 3–3.5 μ; hairs subhyaline to golden yellow, septate, verrucose, encrusted, 60–75 × 3–5 μ; exciple subhyaline, prosenchymatic.

Apotheciis stipitatis, globosis dein cupulatis, dense luteotomentosis, tenue carnosis, 0.2–0.7 mm. diam.; stipite laevi, 0.1 mm. diam., 0.1–0.4 mm. alto; hymenio sulphureo; ascis cylindricis, apice acutis, octosporis, 40–50 × 3–5 μ; sporis irregulariter biseriatis, fusoideis, hyalinis, utrinque acutis, 9–11 × 1–2 μ; paraphysibus lanceolatis, 55–60 × 3–3.5 μ; pilis subhyalinis vel flavis, septatis, verrucosis, incrustatis, 60–75 × 3–5 μ; excipulo subhyalino, prosenchymatico.

On stipes of *Gleichenia* sp., S. of Hanaliioliio, Molokai, Apr. 12, 1928, D. *2810* (type) and above Waemea, Feb. 17, 1928, S. & S. *582;* on stipes of tree fern, Olinda Pipe line, Maui, Dec. 28, 1927, S. & S. *580.*

L. Gleicheniae differs from the various species of *Dasyscypha* described on ferns in the lanceolate paraphyses; from *D. Sadleriae* Stevens and *D. Ulei* (Wint.) Sacc., reported on *Gleichenia,* in smaller asci and narrower spores, and from *D. dicranopteridis* Seaver & Whetzel in color. The smooth stipe and hairs are like those of *D. javanica,* but the spores are only one-half as large.

29. PEZIZELLA CHRYSOSTIGMA (Fries) Sacc. On stems of *Sadleria* sp., Iao Valley near Needle, Waikuku, S. & S. *545;* Waihee Valley, Maui, *547;* on stems of tree fern (*Cibotium* sp. ?), Palolo Valley, *586;* on fern fronds, Palolo Valley, *593,* and Waihee Valley, *590.* The asci are uniformly 8-spored as illustrated by Saccardo (**3**, f. 1359), while Rehm found them to be 4-spored in specimens which he examined.

PEZIZACEAE

20. HUMARIA GRANULATA (Bull.) Quél. On cow dung in pasture, near 27 milepost, Glenwood, D. *3861.*

31. LACHNEA COPRINARIA (Cooke) Phill. On horse and cow dung, Olinda Trail, Maui, S. & S. *556* and *557.*

32. LACHNEA SCUTELLATA (L.) Gill. On dead wood of *Aleurites moluccana,* Iao Valley, Maui, S. & S. *563,* gulch west of Galapue, Molokai, D. *2965,* and Valley west of East Ohia, Molokai, D. *3052a;* on nut of *Aleurites moluccana,* Pupukea Forest, S. & S. *564;* on dead wood, Papolo Valley, Tantalus, and Dutch trail beyond Rogues, Maui, S. & S. *565, 561,* and *562.* *Aleurites* is a host hitherto unreported for this common species.

33. PEZIZA CLYPEATA Schw. On dead wood, Palolo Valley, Oahu, S. & S. *566.*

34. PYRONEMA OMPHALODES (Bull.) Fuckel. On sterilized soil, Honolulu, S. & S. *542*.

ASCOBOLACEAE

35. ASCOBOLUS STERCORARIUS (Bull.) Schroet. On cow dung, Olinda Trail, Maui, S. & S. *541* and *558*.

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3. **Saccardo, P. A.** Fungi italici autographice delineati, *1500 pl.*, 1877–1886.
4. **Stevens, F. L.** Hawaiian Fungi. Bernice P. Bishop Museum Bull. **19**: 189 p., *10 pl., 35 text-fig.*, 1925.

EXPLANATION OF FIGURES

FIG. 1, *Stictis hawaiiensis* on *Rubus rosaefolius*, D. *3776*, × 10; 2, *Lachnum Gleicheniae* on *Gleichenia sp.* D. *2810*, × 10; 3, *Schizoxylon Abutilonis* on *Abutilon molle*, S. & S. *551*, × 6; 4, *Scleroderris Lantanae* on *Lantana camara*, D. *3052*, × 6; 5, *Mollisia petiolaris* on *Hibiscus tiliaceus*, S. & S. *554*, × 6; 6, *Orbilia Abutilonis* on *Abutilon molle*, S. & S. *552*, × 6.

(Photographic negatives by M. L. F. Foubert)

NOTES AND BRIEF ARTICLES

The Bulletin of the University of Utah, volume 28, no. 7, comprises a list of "The Uredinales or rusts of Utah," by A. O. Garrett. This bulletin, consisting of 81 pages and 8 plates, represents the results of 34 years of collecting on the part of the author during which period he has collected in nearly every county of the State. This will doubtless be of great value to students of rusts.—F. J. SEAVER.

A second volume of Grove's British Stem- & Leaf-Fungi announced in Mycologia **28**: 199 has recently appeared. The second volume is a continuation of the Sphaeropsidales. One interesting feature of the book is a list of the Ascomycetes to which certain fungi imperfecti are connected, or suspected to be. These suggestions are very helpful to the student who is attempting to work out the life cycles of some of the Ascomycetes.—F. J. SEAVER.

The American type culture collection of fungi and bacteria formerly located at the McCormick Institute in Chicago has recently been moved to Washington and has been installed in the Georgetown University Medical School Building. The collection will be in charge of Dr. Mario Mollari, Professor of Bacteriology at the University, with an assistant, Dr. Oswald A. Bushnell. Any cultures of new or interesting species of organisms of these groups will be greatly appreciated. A catalogue of the collection is now being prepared. Contributions should be sent as soon as convenient in order that they may be incorporated in the new list.—C. L. SHEAR.

The University of Missouri Studies, volume 12, number 3, consists of "A list of Missouri fungi," by Dr. Willis E. Maneval. The number comprises 150 pages, including an introduction of 10 pages, and a bibliography of 526 titles. More than 1000 species of fungi are recorded. For convenience of reference they are

listed alphabetically without regard to relationship. Each species is accompanied by its synonyms and hosts. In addition to this there is a complete host index making it especially useful to those who are studying diseases of forest plants. Since the fungi are more or less cosmopolitan a check list from Missouri would be equally useful in most of the States of the Middle West.—F. J. SEAVER.

CALVATIA BOVISTA (PERS.) KAMBLY & LEE

This combination, recently proposed by the authors cited (Univ. Iowa Stud. Nat. Hist. **17**: 138. 1936) for the species generally known as *Calvatia caelata* [Bull.] Morgan, is a homonym. As clearly stated on p. 135 of the paper mentioned, Macbride had previously applied this name to the giant puff-ball, *C. gigantea* (Pers.) Lloyd, basing his name on *Lycoperdon Bovista* Fries, which is not the same as *L. Bovista* Pers. The work of Kambly and Lee was done under my direction and I edited the paper for publication, hence responsibility for the error is mine. As indicated in the synonymy given, there were several specific names apparently applied to this species between 1801 and 1889, when Morgan revived Bulliard's name. The application of some of them is, however, sufficiently uncertain to justify the suggestion that pending further study the combination proposed by Morgan and adopted by Macbride, by Lloyd, by Coker and Couch and by other recent students, *C. caelata* [Bull.] Morgan, be retained.—G. W. MARTIN.

At the annual meeting of the Mycological Society of America, in Indianapolis, the Council appointed Dr. S. M. Zeller a member of the Editorial Board to take the place of the retiring member. Western contributors to MYCOLOGIA will, therefore, save time if they send their articles directly to Dr. Zeller for approval before transmitting them to the Managing-Editor in New York.—F. J. SEAVER, Managing-Editor.

MYCOLOGIA FINANCE

(1937)

The 1937 volume of MYCOLOGIA comprised 743 pages, the largest volume issued to date. In spite of its increased size, all of the printing and incidental expenses were paid out of the income and the carry over from 1936. In addition to this $500 was added to the restricted Mycologia Endowment Fund, and more than $1000 carried over to 1938. It is not likely that it will be necessary to increase the pagination much beyond this point, 700–750 pages. Any added income should be spent on the improvement rather than the enlargement of this journal.

When MYCOLOGIA was established one of its purposes was to present illustrations of fungi in color. Owing to the increased cost much of this work has been discontinued. It is hoped that this phase of the work may in the near future be taken up and carried on. To this end a $25,000 endowment is necessary to supplement our regular fixed income. Of this amount $5,000 has already been set aside, partly through private donation and partly through the sale of the early volumes. This fund will continue to grow. Private contributions are solicited. If this program is carried out, it is the intention of the management that each colored plate, published through the aid of this endowment fund, shall be dedicated to some individual who has added to the fund. **Thus, the restricted Mycologia Endowment Fund will stand as a permanent memorial to those who have contributed to its upbuilding.**—FRED J. SEAVER, Managing-Editor.

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